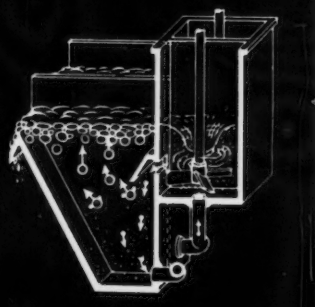
ENGINEERING AND MINING JOURNAL

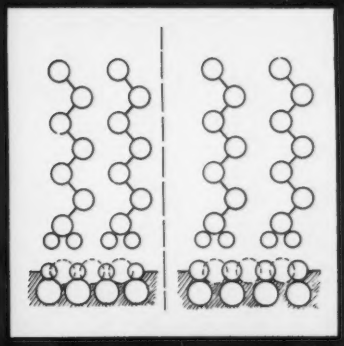
A McGRAW-HILL PUBLICATION

DECEMBER 1961

PRICE ONE DOLLAR

FOUNDED 1866

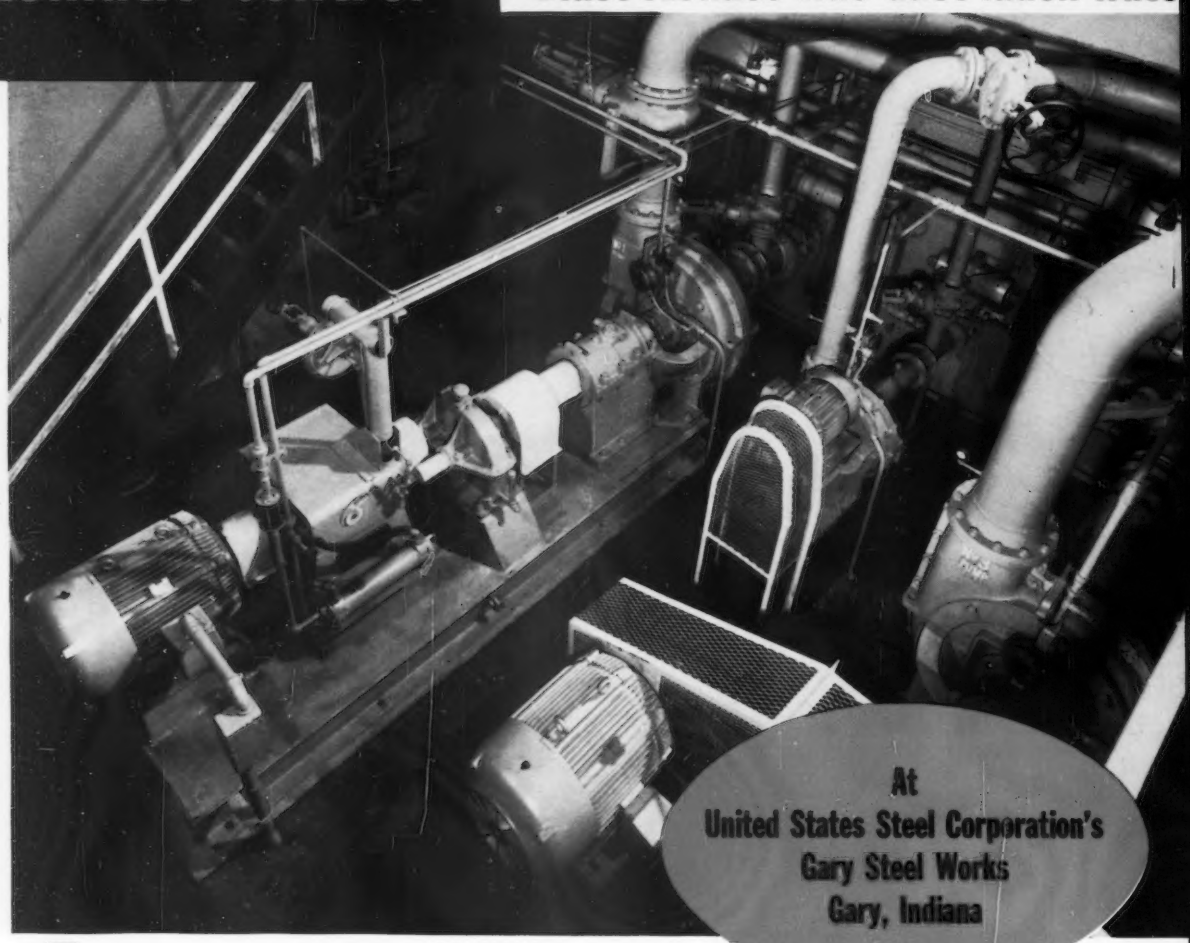




50 Years of FLOTATION ... Its Men, Ideas and Machines ... p 83

Complete pumping installation with automatic control

Blast-furnace flue-dust-laden wate



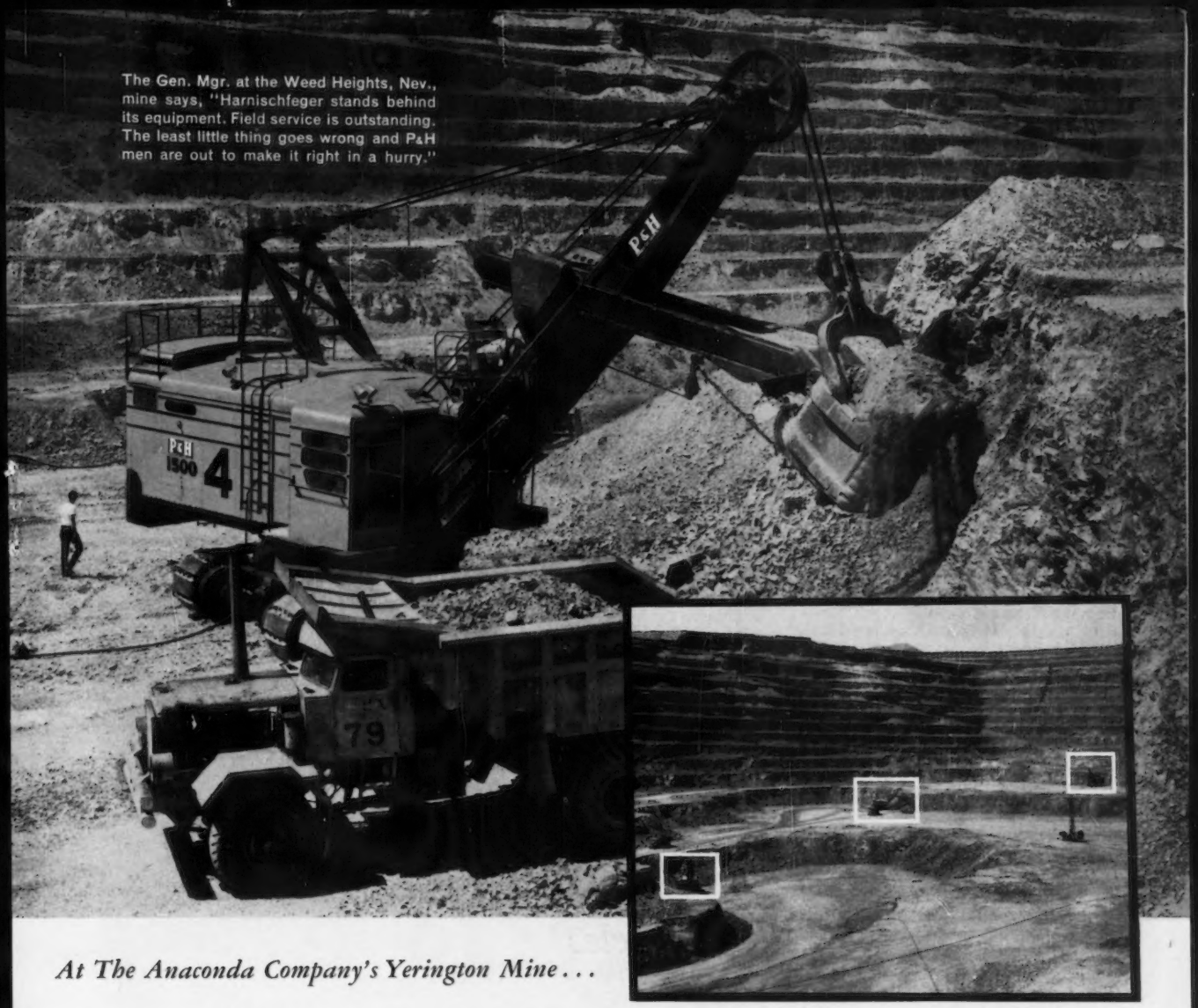
At
United States Steel Corporation's
Gary Steel Works
Gary, Indiana

This A-S-H designed package unit includes three Hydroseal Neoprene-lined pumps: a variable-speed D-6-5, a constant-speed B-6-5, and a constant-speed D-6-5. This system of pumps, valves, and auxiliary equipment operates automatically under a variable load—zero to 10,650 GPM. Have you a pumping-and-control problem? Write us about it.

Write for our Brochure No. 357

THE ALLEN-SHERMAN-HOFF PUMP CO.
Dept. B—P.O. Box 635, Paoli, Pa.
Representatives throughout the World

HYDROSEAL and CENTRISEAL
SAND, SLURRY & DREDGE PUMPS
MAXIMIX RUBBER PROTECTED


The Gen. Mgr. at the Weed Heights, Nev., mine says, "Harnischfeger stands behind its equipment. Field service is outstanding. The least little thing goes wrong and P&H men are out to make it right in a hurry."
P&H
P&H
1500
4
79

At The Anaconda Company's Yerington Mine . . .

4 P&H 5-yd. Electrics × 9 yrs.=100 million tons —"without any trouble whatsoever!"

Anaconda's getting almost fantastic results by using P&H Electric Mining Shovels teamed with their own exceptional shift-scheduling ability and preventive maintenance programs.

"Each 5-yd. P&H loads up to 9,600 tons per 8-hr. shift," says the Equipment Supervisor, "The P&H's cycle faster, give us 100% fill factor, because they deliver more bail pull than any shovel their size. Our P&H's load unblasted ore simply by crowding the dipper into the bank."

26,000 operating hrs. per P&H, no lost production. "Downtime is practically nil," continues the Supervisor. "Parts replacement is at a minimum. We've never had to rebuild. The P&H buckets still have their original dipper shells. I believe Magnetorque Hoist Drive accounts for a big part of the low maintenance factor because it considerably lessens digging shocks." The Chief Electrician adds, "We've no complaints. The P&H hoist motors stand more abuse than those on other machines. We haven't even had commutator trouble in 9 years."

For more details on this job, its scheduling, the maintenance program, write for Case History No. 164.

HARNISCHFEGER P&H CONSTRUCTION & MINING DIVISION

Milwaukee 46, Wisconsin

61-393

Mining Calendar

Symposium on Mechanization of Mines, international meeting and equipment show, Central Mining Research Station, Dhanbad, Bihar, India, Dec. 9-12

Beneficiation and Agglomeration Symposium, 23rd annual symposium of the University of Minnesota, dealing with taconites, pellets and iron ores. U. of Minnesota, Minneapolis 4, Minn. for details. Meeting to be held in Duluth, Jan. 15-17, 1962

AIME annual meeting, New York City, Feb. 18-22, 1962

International Symposium on the Ferroalloy Industry in India, National Metallurgical Laboratory, Jamshedpur-7, India, February 1962

Computers and Computer Applications to Mining and Exploration, workshop and symposium, Stanford University and University of Arizona, at Tucson, March 26-30

Pacific Southwest Minerals Industry Conference, sponsored by the San Francisco, Nevada and Southern California sections of AIME, Palace Hotel, San Francisco, April 12-14, 1962

American Society for Metals, regional conference and exhibition, Houston, Tex. (Shamrock Hotel), April 17-19, 1962

Pacific Northwest Regional Minerals and Metals Conference, AIME-ASM, Benj. Franklin Hotel, Seattle, Wash., April 26-28

5th Rock Mechanics Symposium, sponsored by Colorado and Missouri Schools of Mines, Penn State and U. of Minnesota. At U. of M., Minneapolis, May 3-5, 1962

Wyoming Mining Assn., annual convention, Jackson Lake Lodge, Wyo., June 8-9, 1962

Coming Up

The Mission Unit — American Smelting and Refining Co. dedicated its new mine and concentrator outside of Tucson last month, and E&MJ was a grateful participant. The Mission Unit, named after the neighboring San Xavier Mission, represents the latest in the art of mine planning, development and production. The concentrator, too, is modern, efficient, and designed for tight, smooth operation. Asarco's line staff is justifiably proud of having brought the Mission unit in six months ahead of schedule, with concurrent savings in money, equipment and time. How they did it will be the main feature of the January issue.

Drilling and Blasting Taconite—By using more explosives in the breaking of taconite, Reserve Mining Co. and Erie Mining Co. markedly improved over-all mining efficiency.

95th YEAR OF PUBLICATION

ENGINEERING AND MINING JOURNAL

DECEMBER 1961

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Volume 162, No. 12

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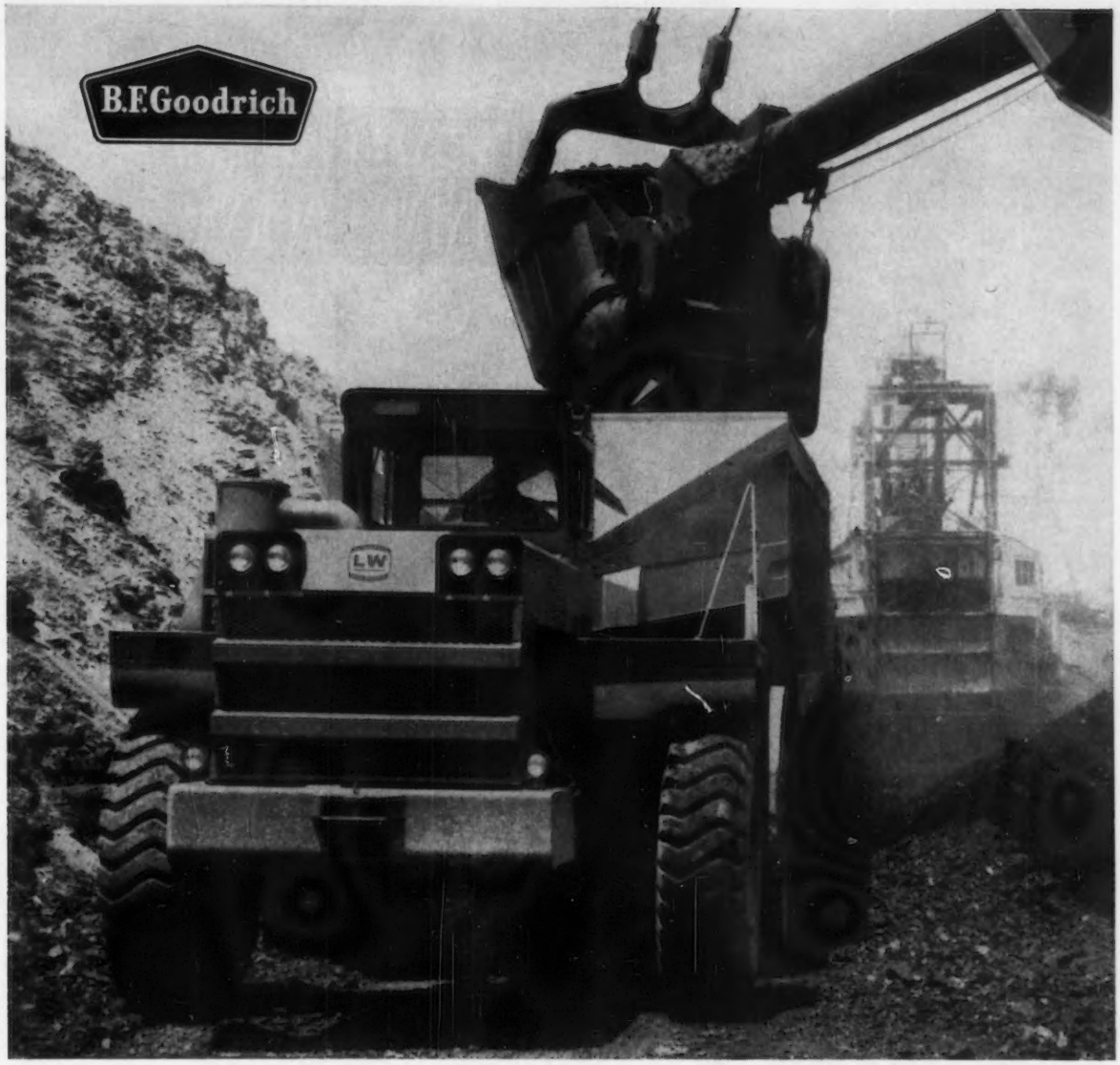

New B.F.Goodrich tire compound takes 90-ton jolts in stride

MINING COMPANY FINDS BFG TIRES LAST 4,000 HOURS ON ORIGINAL TREAD

THAT giant tractor-trailer hauls 90 tons of coal at a clip from mine to tipple. It's part of the fleet operated by Pittsburgh & Midway Coal Mining Co. at its Paradise Mine near Drakesboro, Ky. Trucks work 14½ hours a day over roads spotted with razor-sharp rock. For this tire-killing job the company uses B.F.Goodrich Rock Service tires with new Cut Protected (CP) compound, finds they last as much as 4,000 hours on the original tread.

BFG developed CP compound rubber to defy rock cuts and snags. CP compound helps prevent premature tire failure that can send costs skyrocketing and production plummeting. Under this Rock Service tread is B.F.Goodrich Flex-Rite Nylon cord construction—twice as strong as conventional cords, ready and able to resist heat blowouts and flex breaks. Many users report Rock Service tires can be retreaded over and over.

Take a tip from successful mine operators. Switch to B.F.Goodrich Rock Service tires with new CP compound (Heat Resistant or regular compounds, too). Your B.F.Goodrich dealer's tire know-how and service facilities will help you cut the cost of doing business. Look him up today under Tires in the Yellow Pages. *The B.F.Goodrich Company, Akron 18, Ohio.*

Specify **B.F.Goodrich Tubeless or tube-type tires when ordering new equipment**

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Articles in this issue of

ENGINEERING AND MINING JOURNAL

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83 Salute to the Men Who Made Flotation Work

In our communications with men now active in the flotation field, and a search through many decades of literature for the feature article on flotation in this issue, we soon became convinced of two things: (1) No one person can be designated as the father of flotation, and (2) progress made in this process has been dependent upon the contributions of many men serving in many capacities —from the inquisitive millman peering into his vanning plaque, to the brilliant inventors, educators and researchers who built machines or analyzed the molecular structures and bonds that cause mineral particles to cling preferentially to the bubbles bearing concentrates to the surface. To accord full credit to the many men who have advanced the art would be a monumental task, beyond the scope of this publication. But rather than default completely, we have selected a cross-section of many who through their inventions, discoveries, contributions to literature etc. have helped make flotation what it is today. To the deserving who may have been omitted, we express our sincere apologies—and of course there is always the Letters to the Editor column where additions to our list can always be nominated. In a similar manner our gallery of photos is no more than a cross-section of the many whom you see in the mills, mining meetings or technical sessions where flotation men who advance the art are to be found.

92 Closed Cycle Production of Lead, Zinc and By-Products

Researchers at Belgium's Balen works have successfully devised a unique method by which the extraction of all the many metals occurring in zinc and lead blende has not only become technically feasible, but also economically profitable.

At Balen, some 14 products are produced from an integrated electrolytic zinc plant, a lead plant and a sulphuric acid plant. According to researchers and engineers at the Vieille-Montagne plant, only an integrated lead and zinc plant can be run at a high operating efficiency and at maximum profit.

The Balen industrial complex, owned by Societe Anonyme des Mines et Fonderies de Zinc de la Vieille-Montagne, is also processing zinc-rich slags originally discarded. Newest addition to the zinc plant is a third moving-bed furnace.

99 A Good Neighbor Institutes a New Mining Method

Building land reclamation right into its mining plans is paying off for American Cyanamid's Agricultural Division in Florida. The company, by increasing the cost of mining to a degree, is deliberately reclaiming land as it mines to provide future homesites and possibly citrus groves—one of the biggest gains of the program should be improved community relations.

100 USBM Details Radon Longwall Stoping Operations

When Hecla decided to longwall the Radon uranium deposit near Moab, Utah, it believed the system could furnish a higher-grade ore than open stoping, although its mining costs would be higher.

Because Radon is the only metal mine in the U.S. to use the longwall method with steel props, mining men have been much interested in its success. Accordingly, E&MJ has abstracted an excellent Bureau of Mines report that details the operation and also furnishes some costs.

"Threads of Gold" for a Roman Toga

The mineral *Chrysotile*, meaning golden fibers or threads, supplies over 90% of the world's asbestos requirements. Called the "miracle mineral" by the ancients, the Roman naturalist Pliny (23-79 A.D.) refers to the use of such materials as "a rare and costly cloth" used for the funeral garments of kings.

The secret of the great usefulness of asbestos lies in its unique combination of fibrous structure, fire and water resistance, flexibility and strength. Since the profitable recovery of asbestos fiber depends upon fine crushing without destroying fiber length, a crusher that will perform such functions economically and will produce large quantities of finely crushed material is essential.

Proof of the world-wide acceptance of Symons® Cone Crushers in asbestos production is found in the field, where practically every major producer employs these high capacity, economical machines . . . *as in all of the great ore and industrial mineral operations the world over.*

SYMONS CONE CRUSHERS
. . . the machines that revolutionized crushing practice
. . . are built in Standard, Short Head and Intermediate types, in capacities to over 1500 tons per hour.

SYMONS . . . *a registered Nordberg trademark known throughout the world.*

Specify Non-Metallic **NORDBAK®** *for backing manganese crusher parts.*

NORDBERG

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C461

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ENGINEERING AND MINING JOURNAL

Ye Christmas Greetings

We've lots of other things to do
Before we get to '62
—An article or two, or three,
A new stand for the Christmas tree,
(The wife's idea) And then the kids
Are making not-too-subtle bids—
But we digress. Here's this year's rhyme
To celebrate the Christmastime.

At best, we'll list a very few
Of those to whom our thanks are due
For cordial help, or welcome news,
Or markedly divergent views.
So, if your name does not appear
Among the handfull written here
We hope you'll read our good intent
And know that you're the one we meant.

Send a partridge in a tree
To Marion Bolton, Kerr-McGee,
John Reed, David Mann, Will Reck,
And to Tony Malisek,
Stewart Hurlburt, Charlie Earl,
Jack How, J. C. Keiffer, Merle
H. Guise. And offer gifts to gladden
The hearts of Mrs. and Bill Haddon.

Before we put another name in,
We'll wish good times to A. C. Daman,
And greet the group whose uttered pearls
Are duly noted by Bob Searls:
Reiser, Hennebach, Ledoux,
Bloecher, Jacob, Spedden, Lou
Cassara, Newell A., Neil Ross
—And the gals who let them think they're boss.

We'll ask Don Warnes down at St. Joe
To join Ed Schmid and Larry Roe
Around the blazing yule-log fire
With Van H. Smith, S. H. Cohlmeyer
E. P. Cadwell, Ed Crabtree
D. J. Pope, M. MacAfee
Norb J. Dernbach, Bingham's "Mike"
C-C's W. Van Slyke.

Pass the wassail round agayne
For Alec Jordan and Jean Payne
Greet Abe Morris down at Ray,
Roy Anderson at Pend Oreille.

In fact, we all might lift the cup,
Silver's finally going up!
After low-days comes a high-day.
Merry Christmas, Lucky Friday!

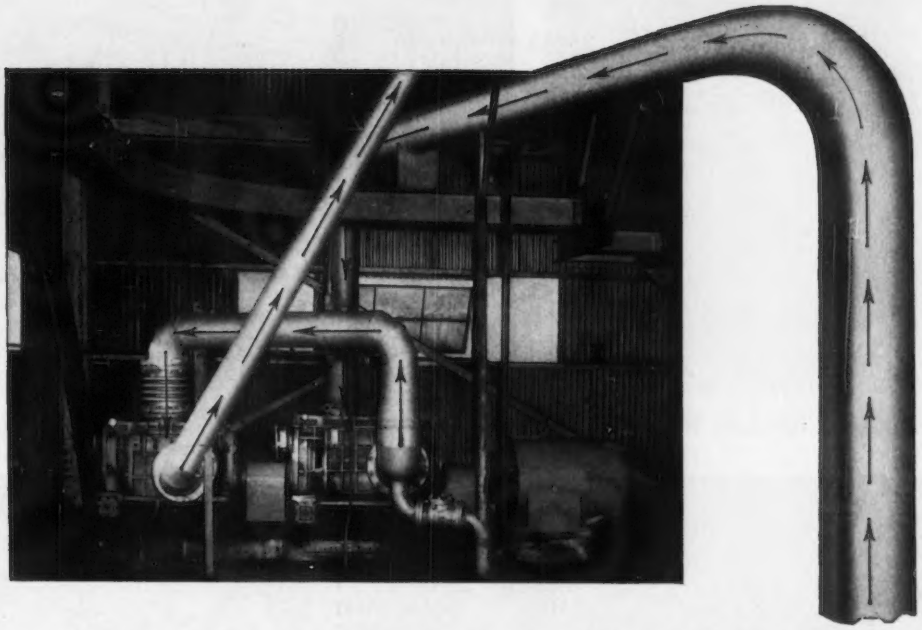
To make the Yule complete, we'll need
The smiling faces of Ned Read,
John S. Rinehart, Karl Lindell,
V. C. Wansbrough, H. Barkell,
C. B. Moore, Bill Stephenson,
Bert Millar, Frank Milliken,
R. H. Pearson, Dick Lund, Jim
Richardson, John Bley, Fred Timm.

Before the Christmas lights are strung
Apologies to Gavin Young.
We hope the merry season's pace
Finds us back in his good grace.
It is the season of good will.
And while we're rueful, we would still
Like to set the record straight—
Vitro makes U_3O_8!

Bonne Noël, y plus bon chance
To Clarence Zeuch, Leo La France,
Ronald R. McNaughton, Wayne
Apuli, Bob Doyle (State of Maine),
Ed Renouard, Ken Merklin, Raul
Bailleres, Franc Joubin, Ken Powell;
And all the good things in the book
To Carl Stunz, Paul and E. F. Cook.

Let's ease frustration-on-the-job
For Jesse Johnson, Charlie Schwab,
And keep things running well at Dawn,
And for friend Keegal's Leprechaun.
For E. C. Stephens, all that's fine,
Ditto Eby, Shea, La Bine,
Robert Hardy, L. F. Pett,
Eldon Gilbert and John Jett.

We've tried again, for what it's worth,
To greet you all. Excuse the dearth
Of talent, meter, rhyme and sense.
(The greeting's small, the wish immense.)
And for these days, which all seem most
Upsetting, — if we wrote the toast,
We'd wish you all calm strength, great mirth,
Some quiet hours—and peace on earth.



VACUUM CLEANING WATER

Axi-compressor

demonstrates many advantages on

FILTER SERVICE

At the O'Donnell #2 coal-cleaning plant of the Rochester and Pittsburgh Coal Co. in Gilmer County, W. Va., an Ingersoll-Rand two-stage Axi-compressor has solved two problems frequently encountered in vacuum filter service.

The continuous disc-type filter used to remove fine coal from the wash water is located on an upper floor. To avoid long runs of suction piping, it was necessary to find a vacuum unit light enough and sufficiently free from vibration to permit installation on the same floor level as the filter. The use of the Axi-compressor resulted in substantial installation cost savings.

The Axi-compressor shown above easily met all vacuum requirements. This two-stage unit produces a steady vacuum of 24" hg at the suction inlet, and still has ample reserve capacity.

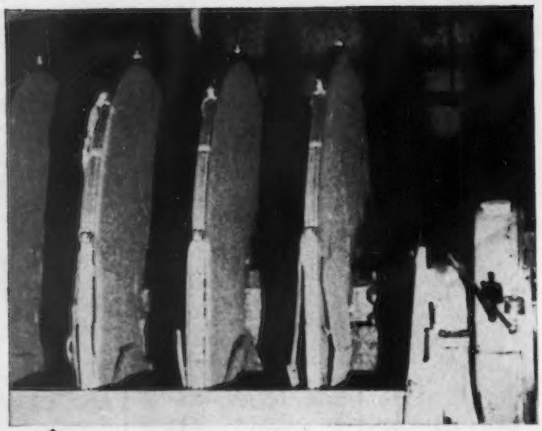
Axi-compressors are now available in low- and high-pressure designs, for capacities from 100 to 18,000 cfm. Ask your Ingersoll-Rand engineer for complete information.

Ingersoll-Rand

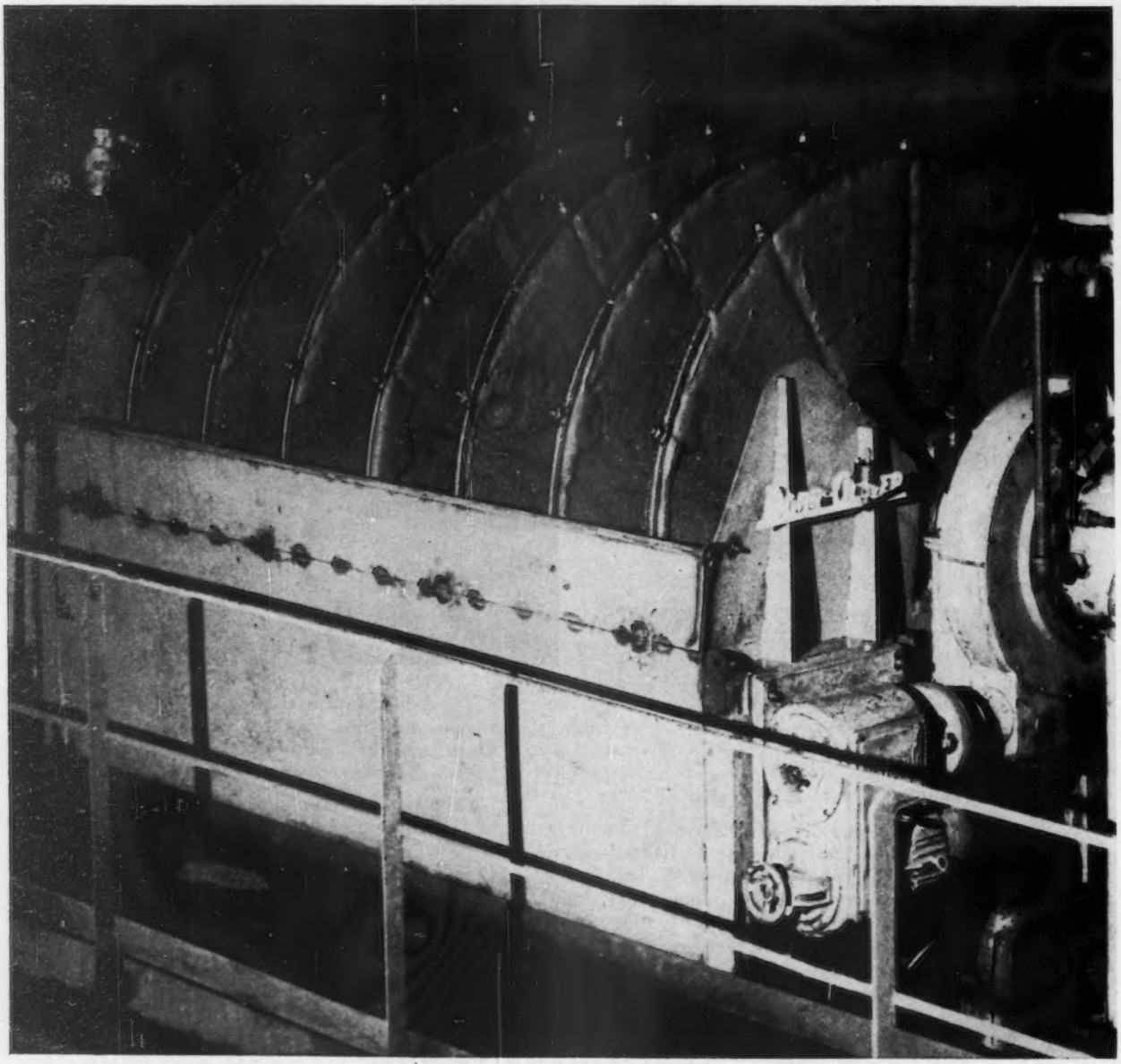
272A17 11 Broadway, New York 4, N.Y.

THE WORLD'S MOST COMPREHENSIVE COMPRESSOR EXPERIENCE

Close-up of filter discs illustrates high degree of water removal. Bags are almost completely dry.



Clean discharge of filter cake, after the snap blow, is shown in this photo. Blow-back problems have been largely eliminated.



How they licked a tough filtration job at The Cleveland-Cliffs Iron Company . . . with **AMERICAN Disc-Type FILTER** *for Iron Ore Concentration*

De-watering re-ground specular hematite, prior to the pelletizing operation, has presented a difficult job at The Cleveland-Cliffs Iron Company's Eagle Mills Pellet Plant, Eagle Mills, Michigan. Feed to the filter contains about 72% solids. The material is heavy and hard to keep in suspension. A high degree of moisture removal and continuous, high tonnage operation is necessary for economical processing.

Close cooperation between Dorr-Oliver engineers and the mill operators has resulted in a successful solution. A 6'9" x 7-disc American Vacuum Filter, designed specially for this operation, is used. The photographs demonstrate the excellent results being achieved. Cake is discharged with an average moisture content of 7.5% to 9.0%. Output runs as high as 118 long tons per hour. Maintenance requirements have been kept to satisfactorily low levels.

The know-how of Dorr-Oliver engineers is based on over 50 years of handling every type of filtration problem, using every type of filter. For information on the wide range of Dorr-Oliver equipment or for assistance on your particular operation, write to Dorr-Oliver Incorporated, Stamford, Connecticut.

DORR-OLIVER

WORLD-WIDE RESEARCH • ENGINEERING • EQUIPMENT

CAROL PROJECT

Completion next year of the Carol beneficiation plant of Iron Ore Company of Canada, will make marketable a vast new supply of Labrador iron ore.

Located in the Carol and Wabush Lakes area, the plant's 7-million tons-per-year capacity will make it one of the largest in North America. The plant will be completed in the second half of 1962.

Canadian Bechtel furnished design engineering, is supervising construction of the beneficiation plant and designed the project's pilot plant.

Important advantages of Canadian Bechtel services include:

- **depth of experience**
- **complete, integrated services**
- **the resources of one of the world's largest engineer-constructors**

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GOODYEAR

Q: What do Goodyear Earthmover Rims have that no others have?

A: MORE times FOUR

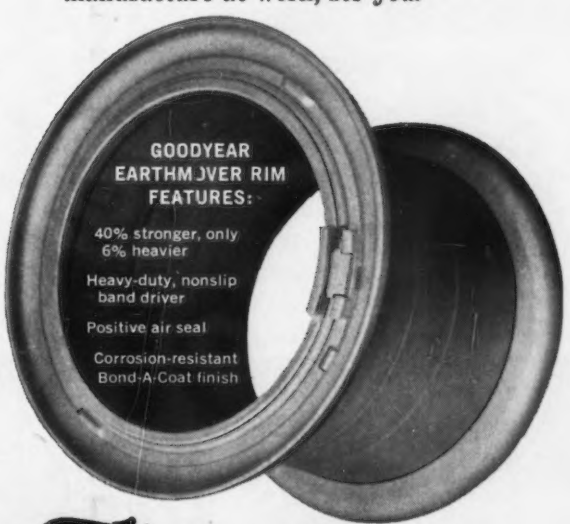
1. MORE rims on the job: More tons are hauled on—more earth-moving equipment rides on Goodyear rims than on any other kind. Result: You reap the benefits of the widest, soundest experience in rim design, manufacture and use.

2. MORE kinds of rims: Maximum rim performance stems from proper specification. Goodyear makes the *only complete line* of earthmover rims. Result: The choice that permits you to get exactly the right rim for the job.

3. MORE rim engineering help: Goodyear has more engineers designing *and selling* rims than any other company. And they know tires, too. Result: The help you need in choosing the right rim for top performance—longer tire life.

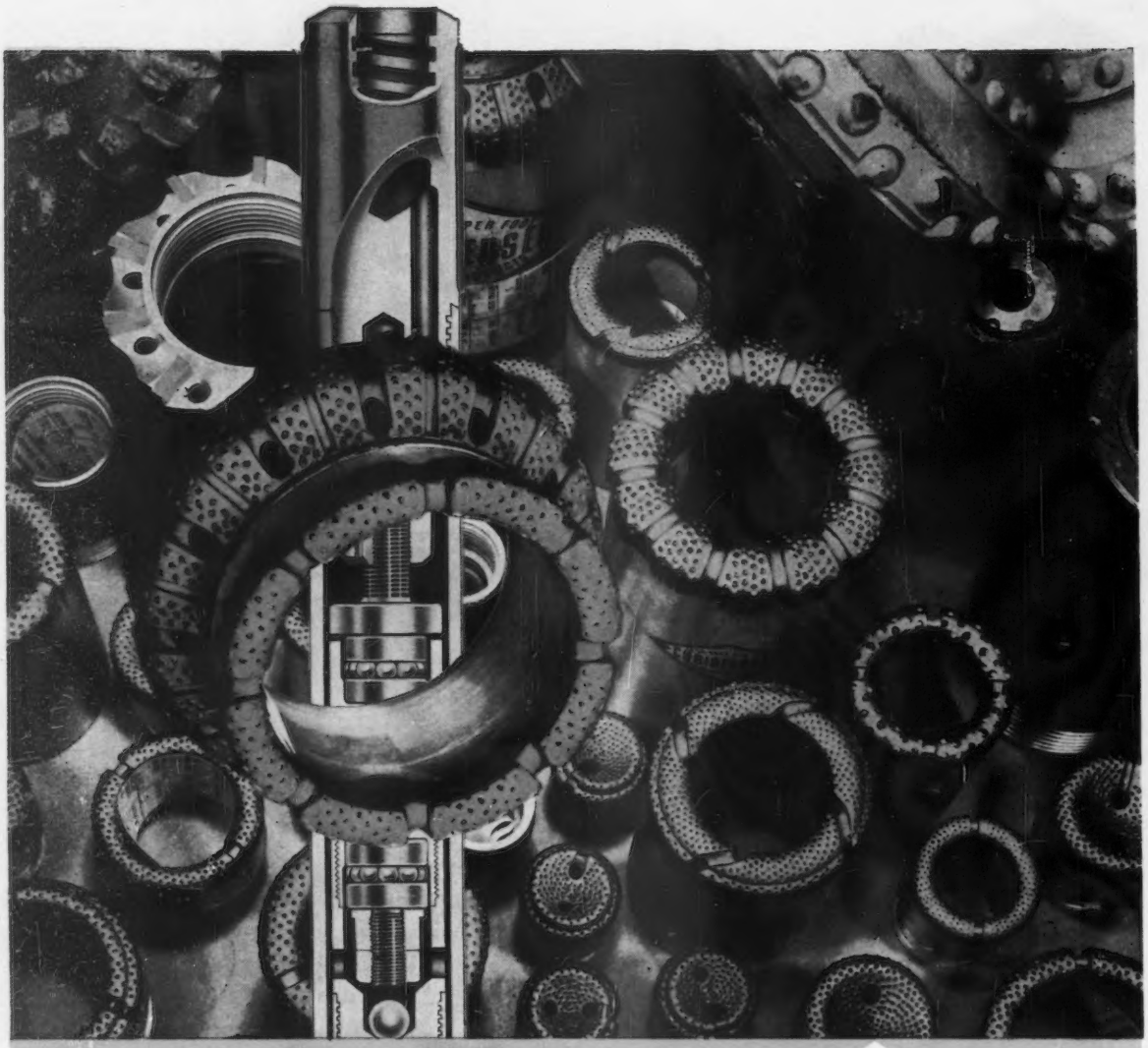
4. MORE rim "firsts": The first *true* earthmover rim, the first 5° rim, the first tubeless rim—in fact, every major earthmover rim advance was made by Goodyear. Result: The very latest in rim design and manufacture at work, for you.

What better reasons for choosing Goodyear as your rim supplier? Only these: The desire and ability to design and build any rim that may be needed for *tomorrow's* earth-moving equipment. No matter what your rim needs or plans, you'll find it pays to call on Goodyear. See your local rim distributor, or write: Goodyear, Metal Products Division, Akron 16, Ohio.



Lots of good things come from

GOODYEAR



Overcome Your Coring and Drilling Problems . . .

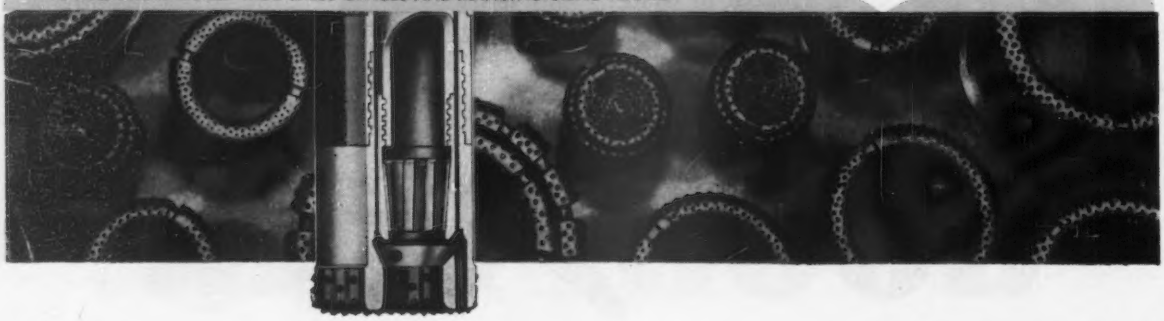
. . . with Christensen diamond bits, reaming shells and core barrels custom designed, through experience, engineering and research, to lower your cost per foot. Security Roller Cone Bits* are also available from stock for your convenience. Contact Christensen today. **Western states only*

"Less cost per foot"

CHRISTENSEN DIAMOND PRODUCTS

MAIN OFFICE AND PLANT 1937 SOUTH 2nd WEST
SALT LAKE CITY, UTAH

SERVICE FROM WORLD-WIDE SALES OFFICES AND MANUFACTURING PLANTS



DO YOU HAVE FAULTING PROBLEMS?

TWO VETERAN NORTHWESTS at Fort Hall Wyo.

The NORTHWEST 80-D Licks Them Profitably!

J. R. SIMPLOT CO., operates the largest open pit phosphate mine in the West, at Fort Hall, Wyoming. Simplot moves over a million tons of combined phosphate rock and shale.

The ore beds in Idaho and southwestern Wyoming have folded, faulted, and eroded. This has made mining difficult and the most careful mining control is necessary.

J. R. Simplot has found that the answer to economically mining phosphate under these conditions was the 2½ cu. yd. Northwest 80-D. Northwests handle the mining of the phosphate and wastes the limestone. They assure good capacity and yet are small enough for selective mining. Even the low grade ores are mined profitably! Northwest 80-D's have proved the best for the several jobs they are called upon to do. Here is mobility, power, the smooth operation and control that make possible the profitable handling of even narrow, scattered, lenses.

Many mine operators have found that Northwest advantages produce their ore at less cost. Let us tell you more about Northwest features for mining.

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That baffling illustration diagrams the torturous path taken by electrical mining cable in a machine we designed to duplicate actual service conditions right in the Laboratory. Nothing ruins electrical cable faster than reeling and paying off a kinky, twisted cable under tension. A sudden snap can tear a conductor right out of the cable. We couldn't expect miners to baby electrical cable, so we designed the test machine to make sure they don't have to. It tests abrasion resistance, reeling under tension, heat aging, flexing and kinking.

The result is USS Tiger Brand Amerclad mining machine cable. Our testing has enabled us to design a cable that takes tension evenly on all conductors so that it doesn't kink or twist, and to insulate and jacket it with specially compounded materials to resist heat aging and abrasion. And we have the test results to prove that Amerclad's construction soaks up shock, vibration, and stands up to crushing impact, severe jerking and pulling. It's the toughest electrical cable money can buy.

For every special job there's a standard USS Tiger Brand wire and cable. For the complete story on Amerclad cable, write American Steel and Wire, Dept. 1217, Rockefeller Building, Cleveland 13, Ohio.

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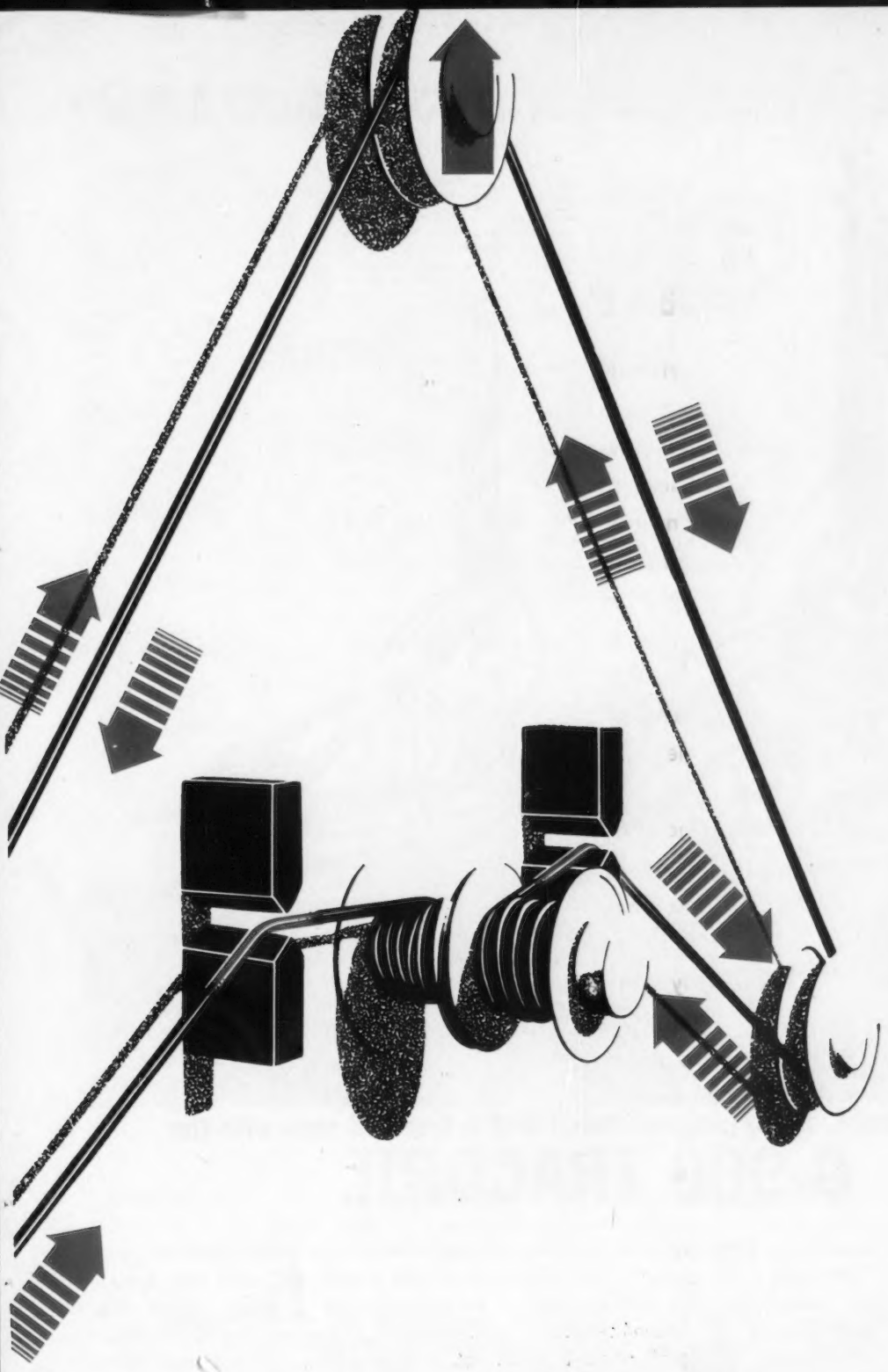
Cable under 100 pounds tension is reeled back and forth until failure.

Adjustable counterweights on middle sheave keep cable under tension.

Distributor guides are principal wear points to cable. Sheaves are secondary wear points.

Cable under 55 ampere load during test.



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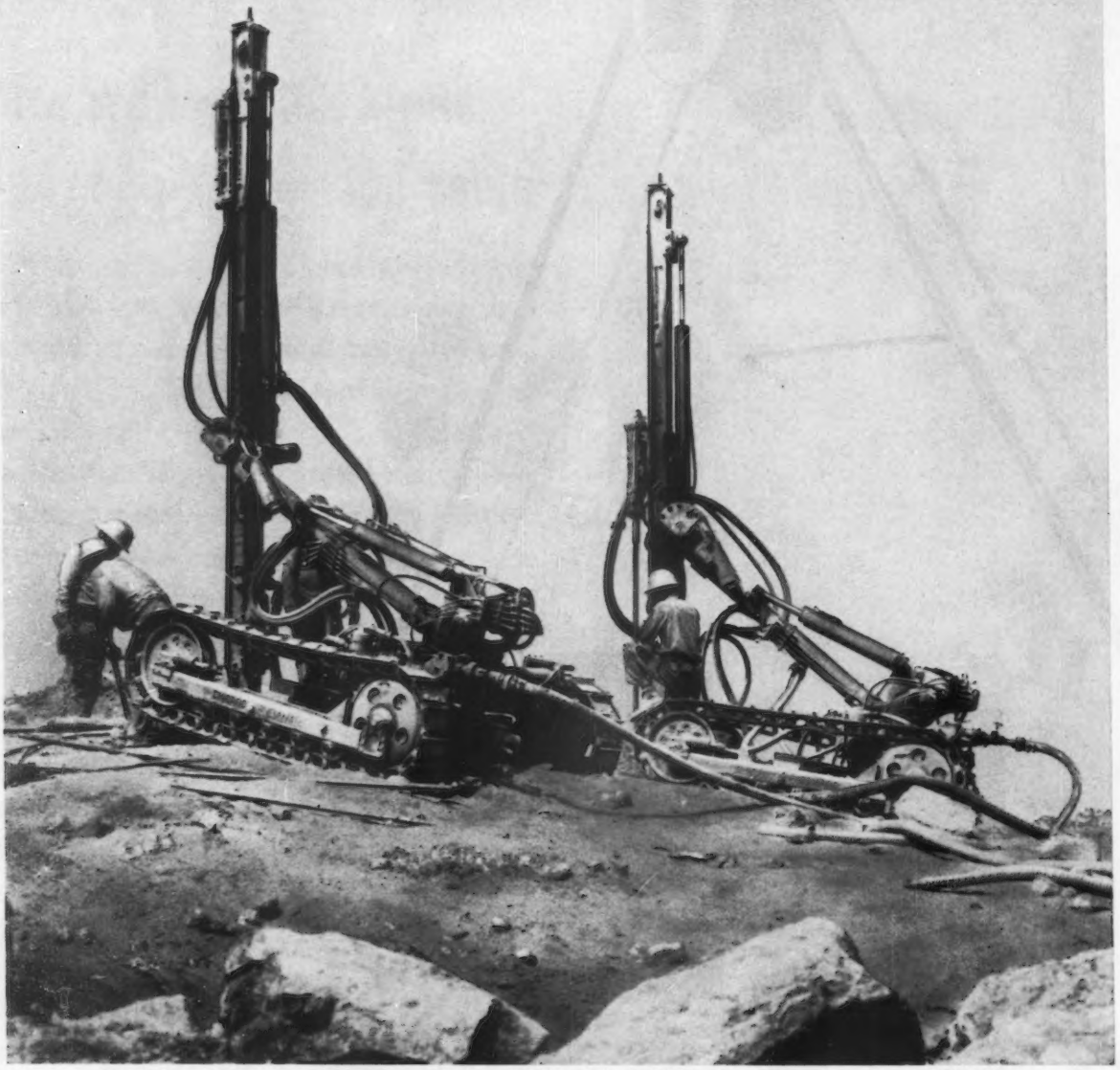
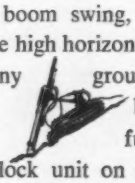
G-900 Tracdril's have earned the respect of drillers for safe, sure-footedness when "set-ups" are toughest.

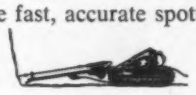


Pick a pattern . . . any pattern! You'll drill it fast and easy with the

G-900 TRACDRIL

"Boarding House Reach" describes the G-900 Tracdril's ability to cover any drill pattern with a minimum number of moves. With 180° horizontal boom swing, G-900's can drill at right angles over the tracks, left or right . . . handle high horizontals to 11 feet . . . toe holes at ground level. Big, sure-footed tracks beat any ground condition . . . provide a solid drill mount. Dual drill positioning controls, at turret and boom end, assure fast, accurate spotting . . . maximum drilling time. "Dead man" controls and fully automatic brakes that slam on the instant tramming throttle is released, lock unit on steepest slopes or treacherous terrain.





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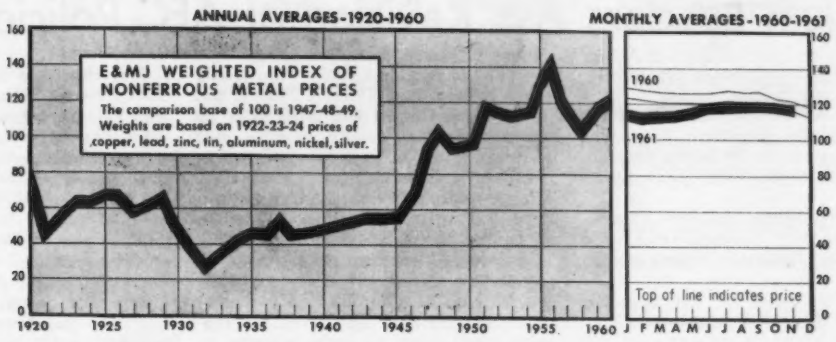
E&MJ OUTLOOK

PRICES


ANNUAL AVERAGES-1920-1960
MONTHLY AVERAGES-1960-1961
E&MJ WEIGHTED INDEX OF NONFERROUS METAL PRICES
The comparison base of 100 is 1947-48-49. Weights are based on 1922-23-24 prices of copper, lead, zinc, tin, aluminum, nickel, silver.
1960
1961
Top of line indicates price
J F M A M J J A S O N D

MARKETS

E&MJ's nonferrous price index dropped significantly to 11.527 in November from 120.386 in October. Silver's end-of-month surge from 91.375¢ to 92.313¢ failed to counterbalance a drop in the lead price from 11.000¢ to 10.203¢. Tin moved up from 121.042¢ to 122.913¢ this month, and copper, zinc, nickel and aluminum were unchanged.

Just how high silver might rise remained unknown at the end of the month. The President's action on Nov. 29 (see p 19) pushed it up over a dollar and forecasts ranged from $1.05 to $1.15 per oz as the final "shaken out" price.

AT HOME

Fears that a new gold flight might be occurring abated in the last week of the month when the Treasury's gold stock held firm for the week. In the previous seven day period, Treasury suffered the greatest weekly loss on record with a $300-million drop. The major part of the withdrawal was traceable to a transfer to Great Britain, which some authorities said could be explained by large pre-Christmas imports of British goods into this country. Britain, when it finds its dollar surplus growing converts some of them into gold.

Newmont Mining Corp. will acquire 80% ownership of Magma Copper Co. under a proposed exchange of preferred stock. The offering will be made to other Magma stockholders (Newmont already holds 21%) once approval of Newmont stockholders, and the SEC is obtained.

Construction is starting this month for a 300 tpd gold concentrator at the Gold King mine near Wenatchee, Wash. The unit will be put into operation next spring by L-D Mines, a joint venture of Day Mines, Inc., and Levitt Mining Co.

More than one-half of all shipments of sulphur in 1961 are expected to have been in molten form, according to Freeport Sulphur Co. The growing preference for molten sulphur is a natural trend, the company says, because its simplifies some process steps and eliminates many materials handling costs.

LABOR

Major unions will begin the new year with plans for a major drive for the shorter work week to ease the impact of automation. In the Governmental area, the unions seem bound to a defensive role to keep what they've got rather than to a plan for greatly increased gains. See p 21.

ABROAD

"A revolutionary steel process" may be disclosed by Ishikawajima-Nakamura Heavy Industries of Japan following receipt of patents from the Japanese government and 10 other nations. Dr. Hajime Nakamura, inventor of the process, refused to disclose details, but said the process is applicable to any kind of furnace, requires no additive, and takes less time. The IN steel, Dr. Nakamura says, features higher tensile strength, shear strength and elongation than comparable steels.

Brazil is beginning to get the massive aid promised earlier in the year. One big loan will go to financing Brazilian metal imports, primarily copper. Some $50-million will be offered to help cover Brazil's imports from the U.S., which run to $420-million annually for all products.

THIS MONTH IN MINING

Uranium Leaders Ask Revision of AEC Policies

FIRMS WITHIN the domestic uranium industry are emphasizing necessity for a new round of Government backed exploration greater flexibility concerning property transfers in 1962-1966 program and start on a post-1966 procurement study.

These were among highlights of testimony in November at Moab, Utah, once the self-styled "uranium capital of the world."

Taking the views of the domestic producers in the first field hearing by the raw materials subcommittee of the Joint Committee on Atomic Energy of the Congress were subcommittee chairman Wayne H. Aspinall (D.-Colo.) and U.S. Sen. Wallace F. Bennett, (R.-Utah) a member of the Joint Committee.

Richard S. Newlin, vice president of operations for Anaconda Co. and spokesman at the session for the Atomic Industrial Forum, said that domestic uranium purchasing, which exceeded $300-million in 1960, made uranium the third most important metal produced in the U.S. from value standpoint, after copper and iron in that order.

Mr. Newlin said the domestic industry had invested some $500-million in facilities, leases and exploration in last 14 years. He predicted a program of high-grading and loss of huge investment if there is no assurance of any purchase plan past Dec. 31, 1966. Mr. Newlin cast doubt, as did other speakers, on accuracy of the AEC's estimate that the U.S. would have between 40-million and 50-million tons of uranium-ore reserves left after 1966.

Such a tonnage would contain between 100,000 and 125,000 tons of U_3O_8.

Mr. Newlin said that electric utilities would show a reluctance to commit themselves to a nuclear power program in 1975, if they had no assurance of supplies in the following 30 to 40 years. This would bring the domestic uranium and nuclear power segment of the United States to the year 2000. He urged that AEC start some sort of an exploration program before the 1966 procurement termination date.

AEC is currently engaged in a study estimating uranium requirements for private power reactors after 1966. The Commission also is engaged in a new uranium reserve study. Atomic Industrial Forum has a like study underway, with reports to be made in March or May.

Mr. Newlin urged that AEC grant substitution of newly developed ore for unfulfilled quotas established under present AEC contracts. He also said AEC should recognize the validity of private industry's request to run natural uranium from the Oak Ridge, Tenn., gaseous diffusion plant.

E&MJ was told later that the State Department was seeking such permission for foreign governments—notably Japan —while the AEC had denied temporarily a like request from General Electric Co.

Mr. Newlin urged that AEC make an announcement at earliest possible date as to the future of its procurement plan.

Miles P. Romney, manager of Utah Mining Assn., said that the U.S. government had spent more than $27-billion on atomic energy in last 14 years, only 27½% of which went to purchase of raw materials. He said that raw materials are the base of "this inverted pyramid" and that removing the producing segment would cause the entire program to collapse.

R. J. Stoehr, coordinator of uranium affairs at San Francisco for Homestake Mining Co., said the AEC's ore allocation plan in connection with the 1962-1966 procurement program was having a serious and detrimental effect on conservation practices and sound mining-methods.

"In order to correct these ill effects, we believe the AEC must now develop a policy which will allow the producers of uranium to deal with one another to consolidate allocations and marketing agreements. This will prevent abandonment of partially mined ore deposits and prevent untimely development of new reserves which must later be abandoned, and eliminate the present practice of high grading.

"There is much skepticism within the industry regarding the accuracy of the AEC ore reserve figures," Mr. Stoehr said. "Will these reserves be mineable, or will these reserves consist of pillars and low grade fringe areas in numerous mines scattered at random across many states and be completely uneconomical to recover?" he asked.

AEC already had predicted a fall-away of some 10,000 tons of U_3O_8 in its 1962-1966 program, Eugene B. Hotchkiss, executive vice president of Vitro Minerals Corp., told the raw materials session.

Yet the AEC in the U.S. has announced it does not anticipate any "short-falls" in deliveries from abroad.

Mr. Hotchkiss emphasized that there would be no Canadian "fall away," in his opinion, because Canadian producers were allowed to consolidate and otherwise substitute good properties for marginal mines so that profitable use could be made of the U.S. purchase agreement.

"It is my contention that the domestic uranium producers are no less deserving than the foreign producers and hence, I urge that prompt and thorough consideration be given to a similar plan permitting substitution of ores by American uranium producers," he said.

These remarks were questioned closely by Rep. Aspinall, who indicated he had been informed to the contrary concerning uranium procurement in Canada. Mr. Hotchkiss is to forward further details of Canadian procurement to the committee. As AEC already has allowed substitution and consolidation in some cases in Wyoming and New Mexico, according to Robert Adams, Denver, president of Western Nuclear, he sees no reason why this plan cannot be extended in the U.S.

Rep. Aspinall wanted to know if domestic producers were awarded rights to consolidation and substitution if they would be willing to share the greater profits resulting therefrom with the AEC and the taxpayers. Mr. Adams said he would be—depending on what AEC considered sharing. Allan Jones, director of the Grand Junction Operations Office told E&MJ that in his opinion contract renegotiation would not necessarily have to accompany such substitutions "in every case." "It would depend on the instance," he said.

The general impression of the producers at the hearing was that AEC was going to speed up its substitutions-consolidations of ore reserves.

Rep. Aspinall told the meeting in the Grand County Courthouse that the "over-all picture of the industry is bluntly one of over-production in face of a diminishing or at least uncertain market."

Dean Cook Cites Vagaries in Wilderness Bill

MINERAL EXPLORATION and development, now permitted in primitive, wild and wilderness areas, under stringent rules and regulation, would be effectively stopped by the Senate-passed wilderness bill.

That is the conclusion of E. F. Cook, Dean of the University of Idaho College of Mines and Director of the Idaho Bureau of Mines and Geology.

Dean Cook said the bill carries no specific prohibition on claim-staking, but he declared that it may be assumed that the digging of a discovery pit, the erection of monuments and any assessment work would be construed under the bill as activity "incompatible with the preservation of wilderness environment."

He cited one section of the bill which states:

"Nothing in this act shall be construed to prevent, within national forest and public domain areas included in the wilderness system, any activity, including prospecting, for the purpose of gathering information about mineral or water resources or to prevent the completely subsurface use of such areas, if such activity or subsurface use is carried on in a manner which is not incompatible with the preservation of the wilderness environment."

He also referred to another section which states:

"Within the national forest and public domain areas included in the wilderness system, (A) the President may, within specific area and in accordance with such regulations as he may deem desirable, authorize prospecting . . . , mining . . . , and the establishment and maintenance of reservoirs, water conservation works . . . including the road construction and maintenance essential to development and use thereof, upon his determination that such use or uses in the specific area will better serve the interests of the United States and the people thereof than will its denial . . ."

Cook then outlined these additional facts about mineral prospecting and development.

1. Almost all prospecting in the U.S. today is done by private industry.

2. It is no longer an individual effort. It's done mostly by teams of highly trained men using complex instruments and it's expensive work.

3. The only incentive for exploration is the right to develop and mine any economic mineral deposit found.

4. Even when the nation needed uranium badly and the government was strongly encouraging exploration for uranium, no area withdrawn from mineral entry was opened by presidential action to uranium exploration.

5. Cook said he knew of no completely subsurface method of mining that might be carried on under terms of the bill. He added that he supposed that, should a deposit be so fortunately located that one could tunnel into it from outside the wilderness boundaries, one might be allowed to mine it.

6. Nothing in the bill requires investigation and evaluation of mineral resources in the determination of areas that are or are not predominantly of wilderness value.

7. Woefully little is known about the mineral resources in the areas affected by the bill.

8. In the past, notably in the Forest Service proposal for the reclassification of the Selway-Bitterroot primitive area (an area of about 1.8-million acres in north central Idaho) to wilderness status, mineral resources have not been considered and mineral potential has not been evaluated, except in terms of the existence of mining claims.

"No company in its right mind," Cook declared, "could afford to take the risk inherent in the bill, could afford, in other words, to bet that the President would allow them to mine what they found — and nobody else is going to do the exploration."

Wilderness Bill Defended by Senator Church

MINERAL PROSPECTING will not be completely abolished in wilderness areas under the Wilderness Bill which has passed

(*Continued on p127*)

As We Went to Press . . .

The price of silver leaped up 9⅜¢ Nov. 29 following an Administration halt of the sale of "free stocks" from the U.S. Treasury. The cessation of sales, which came when only 22-million oz of free silver remained in Treasury hands, drove the price from the 91⅜¢ level which it had occupied since 1934 to $1.0075 on the 29th, where it remained through the 30th.

London and Montreal exchanges also reacted strongly to the restriction, and futures in the latter market, for sales in March and May, rose to $1.04.

Silver producers, who have long advocated the halt of the sale of free silver (see E&MJ, November, p 85) were pleased by the President's action. Silver users opposed the move on the grounds that the Administration should have waited until all the free silver was gone. (Treasury estimated that the 22-million oz would have lasted for another week.)

The remainder of the President's program for silver did not obtain the producers' approval. That program would have Congress, on its return in January, repeal all silver legislation now on the books, including the provision for purchase of all newly-mined domestic silver offered at a price of 90½¢ per oz. Senators Church and Dworshak of Idaho have pledged a fight on the repeal, as have other congressmen and the producers themselves.

Under the Kennedy plan, Treasury will now retire $5 and $10 silver certificates and replace them with Federal Reserve notes. That substitution will guarantee a source of coinage silver for about 10 years. The Government will then ask Congress for permission to do the same with $1 and $2 bills, and obtain a 30- to 35-year supply of coinage metal. (Some opposition may also be found for this move.)

With repeal of the silver legislation would come elimination of the silver transfer tax which has, in effect, prohibited the trading of silver on commodity exchanges. In eager anticipation of such repeal, the N.Y. Commodity Exchange announced plans to begin the trading of spot and forward silver as soon as the law is removed. (The day after the President's announcement, the selling price of a seat on the N.Y. exchange rose by $1000.)

If the Administration gets its way and silver is "gradually withdrawn from our monetary reserves" to provide for "the eventual domenitization of silver except for its use in subsidiary coinage," then the Treasury will be out of the market entirely and the price will be set by a commodity exchange. While silver miners like the idea of being able to use the market machinery to protect against sudden price variations, they would like to keep the insurance that the purchase program represents.

Just how high the price of silver will go remains uncertain. Estimates have ranged all the way from $1.00 to $1.15, with the majority in the $1.10 area. One Administration authority observed that "it might be two weeks before the price shakes out." Meanwhile, producers remain cautiously optimistic—and are watching for new silver flow. For instance, Red China, which had been selling silver in London to buy foodstuffs, is now back in the market with an unknown quantity of silver bullion. Too, producers believe that some silver which had been held off the market in anticipation of the price rise might soon be coming in. Demand, which had been stoked by the last of the free silver, was not strong at the end of the month.

WASHINGTON IMPACT

Highlights

THE BATTLE OVER TARIFFS is already under way, before Congress returns next month.

The Administration is preparing to ask for an across the board tariff cut, aimed at an eventual Atlantic economic community, including the U.S., Western Europe and Canada. President Kennedy is also expected to ask for sweeping authority to negotiate with common market countries and others on tariffs, thus taking away some bargaining power from Congress.

All this will be met by domestic industries who feel they are being pinched by imports. In some cases they will have the backing of the unions.

The stakes are high and a lot of money is being spent on information programs and lobbying projects. In the metals field, the aluminum industry is pushing what it calls a "fresh approach" to the tariff problem. The aluminum industry claims it actually doesn't want higher tariffs but would like to diffuse the impact of increasing aluminum imports. The industry claims that ingot production is now running around 80% capacity and the fabricating side is averaging only 50% of capacity. The industry, backed by its major trade associations and all major aluminum producers, says the new approach being suggested to the Administration would cover these points:

1. Seek Government aid in getting aluminum exporters to voluntarily hold sales to the U.S. pegged to "best year" records to date. Foreigners would get to supply part of the metal to meet increased consumption in the U.S., but on a regulated yearly percentage basis.

2. Promote increase of U.S. aluminum ingot exports by Government negotiation with other countries which cannot supply themselves adequately but which have rigid restrictions against raw metal imports.

3. Seek higher "buy American" differential for sales of U.S. Government contracts. U.S. producers get a 6% "buy American" spread on bids for Government contracts but this gives little help when European bidders are averaging 30% less than U.S. bidders for contracts. The industry suggests a "buy American" differential be 12% to 25%.

This program suggested by the aluminum industry is just one side of the campaign—the soft sell side. There are reports that the aluminum industry may be making an agreement with copper industry leaders to fight the Administration's plans for cutting tariffs. The agreement may even move out of the metals field and embrace such industries as electronics.

Industry forces are putting on a campaign to educate their own workers. In some cases, kits and prepared programs are being circulated as part of a program to show the impact of lower tariffs on workers. Traditionally, many top labor leaders have been for freer trade. But, there is growing suspicion and fear about what could happen to jobs if tariff barriers were lowered. It is this grass-roots support from plant workers that the aluminum, copper and other industries feel might well be exploited.

The Administration is trying to alleviate some of the pressure within a liberal trade policy. In the "buy American" field, the Administration is making some concessions. The massive aid program is the focal point. Theoretically, contracts for metals and other products going into aid programs should be offered to U.S. suppliers because of the boost it gives to the balance of payments. But, contracts have been going to foreign suppliers in aid programs because of the reported disparity in bidding. In many cases foreign bids go 50% below the U.S. bid price. The most spectacular reversal of the policy of buying by price came after the fertilizer industry protested $6-million in contracts going to Japanese bidders for a Korean aid program. Now, the U.S. fertilizer bidders will get the contracts. This policy of "buy American" in aid programs will insure aluminum, steel, copper and other suppliers at getting almost 100% participation in such big programs as India's five year plan. But, those close to the tariff negotiations think this could very well be a temporary concession by the Administration to keep industry sentiment against a freer tariff policy from boiling over.

Actions by France and China Influence Silver

SOURCES close to the London silver market say that Communist China is in the process of dumping bar silver into the world market. The source said that up to 55-million ounces of silver coming from Communist China would be in the market before the end of the calendar year. Communist China is reported to be melting down some of its hoard of silver coins to sell on the market in order to buy wheat, rice and meat for its famine-fringed economy.

Elsewhere in the international silver market, France is also either just out of the silver market or readying to get out—thus taking off one of the world's big monetary silver buyers. France has been buying a steady amount of the metal to make a silver coin in its plan to strengthen the franc. A second coin denomination was scheduled earlier this year but has now been called off, leading market speculators to believe France is just about ready to get out of the market.

News of the Communist Chinese action and reports of possible action on the part of France have silver producers and traders worried. Here and there, according to the London market source, some small holders of silver have been cashing in, unable to wait out the U.S. Treasury's "do-nothing" stand on protecting its free silver stock. This stock has only a couple of more months to go, unless such action as the Chinese dumping and France's withdrawal reverse the delicate world supply-demand situation.

Drastic "Crash Program" Opens in Bolivian Tin

BOLIVIA may be getting a big new spurt of tin production. Just what this might do to the sensitive tin market within the next year or two is anybody's guess. A lot of new production is hoped to come from an intensified push being made by the Bolivian government to open more mining areas and upgrade production in the mines now in operation.

The exploration and production spurt is expected to come after a triangular loan from the U.S., West German and Argentine governments in cooperation with the Inter-American Development Bank. A loan of $38-million over the next two to three years is going directly into COMIBOL, the Bolivian government mining company that was formed to operate the Patino, Hochschild and Aramayo tin mines after Bolivia's revolution in 1952 (these mines account for some 75% of Bolivian tin production).

Since COMIBOL took over, Bolivia's tin production has declined from an average of 33,040 tons to 15,300 tons last year. And in Bolivia's initial tin mining heyday, ore grades were counted at more than 10%. Now, they rarely reach 1%.

No exploration of any consequence has taken place in the mining companies now controlled by COMIBOL in the last 30 years.

The three lending countries putting money into the rehabilitation of Bolivia's mining picture are aiming loan money at a crash exploration program and quick installation of modern methods in the current mining operation.

C. C. Huston and Associates of Canada (mining engineering consultants) were hired to push the most extensive prospecting program in Bolivia's modern history. By next year, $6-million will have been poured into the search for reserves (not just for tin but for silver, lead, zinc and other metals) and new metallurgical research. The Inter-American Development Bank, in order to make the mining loans work, is exacting reforms from the Bolivian government in revamping its mining company. One of the steps contemplated is the firing and replacement in other work of some 5,000 workers out of COMIBOL's top-heavy personnel roster of 27,000.

Foreign and U.S. Groups React to Aluminum Plan

THE ALUMINUM INDUSTRY is getting the first blasts of protest from its proposed plan to ease the impact of one-product, area saturation of imports (see column at left). The big French aluminum companies, the French government and possibly the Belgian government are preparing to combat this plan to curtail future imports of aluminum products into the U.S. Also, the American Association of Aluminum Importers and Warehouse Distributors claims that the aluminum producers' plan to make more "orderly" imports is a "device designed to eliminate the only effective competition on aluminum products in the American market."

Some government sources now claim that the aluminum plan might be, in part, a sort of smokescreen to cover the industry's real interest which is raising the tariffs on imported ingots (not mentioned in the industry's report on imports) up from its present 1¼¢ per lb rate. The U.S. aluminum producers want to at least maintain this tariff at its current rate. Talks in Geneva at the 19th session of GATT centered around the U.S. tariff on aluminum. Canada wants the tariff down to ¾ of 1¢ which is a legal request under the present U.S. commitment to GATT.

The aluminum industry is trying to hold the line here because of the flood of new ingot imports into the U.S. Imports of aluminum ingots into the U.S. this year are expected to be around 390-million lb. Canada is expected to get some 250-million to 260-million of this. Canadians are able to sell at current U.S. market prices even with the 1¼¢ tariff and would really move in more if the tariff were dropped more. Imports of Canadian ingots are running around 20% more this year than last.

Labor This Month

TARGET NO. ONE—The shorter workweek: Union leaders are now focusing on a cut in working hours—without a loss in take-home pay—as the best cure for technological unemployment. Demands for trimming the work week will show up in 1962's steel bargaining, with a probable follow-up by the Mine-Mill and Smelter Workers. Both unions are up for full industry-wide negotiations. However, you'll find the demand clothed in a variety of labels because of the Kennedy Administration's strong opposition to the shorter workweek. The campaign will be directed at "reducing work time"—both at the bargaining table and via the legislative route in Congress. It will look this way:

In negotiations, unions will aim at a variety of ways to cut the 40-hour week—not only by cutting working hours. It could be a three-day weekend for senior employes; longer vacations of 30 to 60 days or even three month sabbaticals; earlier retirements, or shortening the workweek.

In Congress, the demand will center on a change in the wage-hour law's 40-hour week by cutting the standard workweek in slack production periods. Workers would be paid at the 40-hour rate.

AUTOMATION ALTERNATIVES: Other job-saving alternatives will be proposed by labor unions where the short workweek fails. A clue to such approaches comes from the packinghouse workers—who negotiated one of the first automation fund pacts, only to find it a flop. A retraining provision in the meat industry contracts for displaced workers ended up with only eight persons successfully locating jobs out of a potential 400 laid-off employes. In recent new contracts, the parties shifted to a new system. Employes are given a choice of extended severance pay or this alternative: They can claim, on a seniority basis, any job that opens up in another company plant. Union leaders concede even this method has its perils because it tends to freeze older workers in the available jobs and prevents younger workers from coming into the industry.

MINE-MILL ON THE CARPET: Officials of MMSW are slated for another quizzing from the Senate Internal Security Subcommittee. The issue this time is the financial backing for Mine-Mill officials in their legal defense against Government charges of filing false non-Communist oaths under the Taft-Hartley Act. Subcommittee investigators want to locate the source of support for the union officers. Mine-Mill leaders recently tangled with the subcommittee over their pact with the Teamsters.

UNION ORGANIZERS SCORE GAIN: AFL-CIO chiefs, hoping to reverse the declining percentage in union membership, are heartened by two significant moves from the National Labor Relations Board. The five-member board is seeking court injunctions against southern textile employers who have resisted union representation at their plants. If the courts approve, one injunction would require the rehiring of discharged union supporters, while the other would require management to negotiate with the union over an impending plant shutdown.

Anticipating further aid from the NLRB, the AFL-CIO's industrial unions are talking up a new "organize the unorganized" campaign. The move comes at a time of some bad news for the big labor federation. The latest figures from the Department of Labor show that union membership has advanced only 36,000 since 1958—while at the same time the percentage of union members in the non-farm work force has declined from 33.7 in 1958 to a current 32.1%.

ON THE DEFENSIVE: Return of the 87th Congress next month will find labor strategists more concerned with fending off legislation than seeking new gains on Capitol Hill. While the AFL-CIO will be promoting special labor bills on Taft-Hartley and elsewhere, they will be fighting harder to prevent new curbs from being applied by Congress. Sen. John L. McClellan (D.-Ark.), whose investigations of union corruption ended in the Landrum-Griffin Reform Law, now seeks measures that would: 1) Ban strikes in the transportation industry by applying the anti-trust laws to unions in this field. 2) Bar by legislation all strikes and work stoppages on the nation's missile bases.

MARKETS

Free Silver Sales Ended, World Prices Rise; PW Zinc Price Boosted; Lead Price Reverses

THE E&MJ INDEX OF NONFERROUS METAL Prices for November was 119.5% of the 1947-49 average, down from 120.4% the previous month. The decline in the monthly lead average from 11¢ a lb to 10.203¢ more than offset a slight rise in the tin average and the late-month boost in the silver quotation.

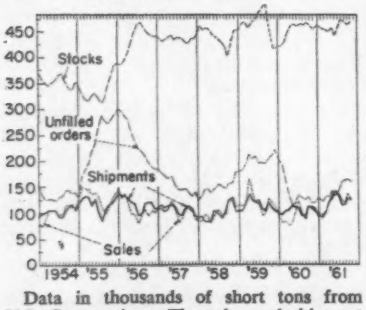
The world's copper markets continued relatively steady in November with sales by U.S. producers and custom smelters remaining at 31¢ a lb delivered. Metal in the outside or resale market was sold at as low as 30¼¢ a lb to consumers. The LME cash price rose to £229.3 from £228.6 in October.

Anaconda settled its contract difficulties at its El Salvador and Potrerillos properties in Chile after a 60-day truce. The company ended reports that problems persisted there by explaining that there had been a 24-hr strike because of confusion created by employee transfers from Potrerillos to El Salvador. There have been no layoffs or cutbacks.

The U.S. market is still healthy. October refined output and deliveries rose and stocks were down 3000 tons. Fabricator data were not as good, with a rather pronounced decline in bookings of new business. Fabricator copper stocks rose 4000 tons. The foreign market was hot and cold with planning hesitancy attributed to Berlin concern.

The lead price of 10½¢ a lb, N.Y., effective November 1, lasted until November 13 when limited buying interest and a waning LME forced another slash. Consumers, with an eye on London, apparently anticipated the move. New York at 10¢ and London at £57½ (7.2¢) hit post-war lows.

U.S. Copper Fabricator Data



Data in thousands of short tons from U.S. Copper Assn. The sales and shipment series are related only to purchases of refined copper by the fabricators, including copper refined by custom smelters from their intake of scrap and concentrates. All statistics refer to brass mills, wire mills and foundries. All series are for fabricated products except stocks which are of refined copper and copper in process. October is the last month indicated. Sales and shipments series are two months moving averages.

Heavy end-month buying and some upward movement in London spurred a ¼¢ increase to 10¼¢ on November 28. Again it appeared that customers were convinced the price could go no lower. October domestic statistics were disappointing in that refined output rose, shipments declined and stocks rose 3500 tons. The LME had recovered to about £60 at the end of November.

Zinc, lead's sister metal, is in the midst of an entirely different situation. Had it not been for the slowdown in premium grade metal sales and the resulting stock buildup, the base price of Prime Western material would probably have risen before it did—on December 1. The new price for PW was 12¢ a lb, East St. Louis, a ½¢ increase.

Zinc sales have been excellent for the past few months with galvanizing demand particularly impressive. With production of 1962 autos, sales of SHG and HG have made a good comeback. Industry statistics confirm this strength. However, a sizeable stock of high grade material remains and the industry practice of discounting premiums appears likely to carry through the first quarter. Two important sellers have indicated they would return to full premiums. One will not take action until Jan. 1, 1962. Other sellers have not followed. Those who feel they were forced to follow discount leaders are reluctant to raise prices and perhaps see customers lost to those who continue the practice. A good chance of improved premium grade activity remains. Such might absolve the abhorred yet sustained practice. PW strength may restore industry confidence in its "paper" premiums.

With an eye on increased imports of ingot and fabricated products, four associations representing the U.S. aluminum industry have come up with a scheme to apportion world markets. The program is aimed at Free World expansion of production and consumption to the advantage of all producing countries, an industry spokesman said toward the end of the month. Sales orderliness is required to prevent a market battle in the U.S., he said, one that might use up funds of all sellers needed for market research. What it now appears to amount to is that the U.S. industry feels imports are hurting its markets and that chance of tariff assistance from the present Administration is slim. Without doubt, a plan that would be beneficial to both the U.S. industry and exporters to the U.S. is better than no help at all, many feel. The industry must now sell the idea to the U.S. Government and foreign producers.

October output was 167,295 tons (79.3% of capacity), up from 159,572 (78.2%) in September. September primary stocks fell 4,000 tons.

World silver prices moved up sharply with announcement by the U.S. Treasury that it would no longer sell from its "free" stock. The Handy & Harman N.Y. price moved immediately to 100.75¢ from 91.375¢ and London jumped to 85½d.

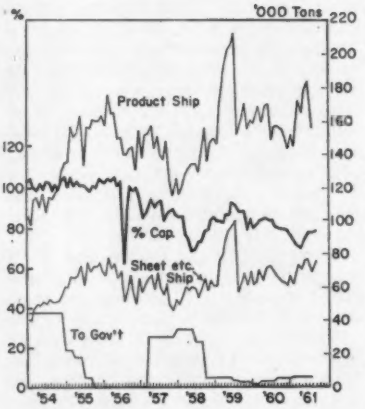
Consumers were well prepared for the move and producers were pleased with the price rise, but there is more of the Administration's program to come. It calls for end of the Treasury guarantee to buy newly-mined domestic silver at 90¼¢ when offered. Silver states will fight the move. Repeal of the silver transfer tax is also expected. The N.Y. Comex is ready to begin trading.

Consumer tin demand was quite light in November, but a technical nearby tightness early in the month pushed prices to 123.625¢. As the tightness eased, prices fell off to close the month at 122¢ (LME £949).

Highlights of the month were two GSA Longhorn tenders. On November 8, all bids were rejected on 850 tons of grade A, although the highest offer was only 1⅛¢ below the prevailing market price.

It is to be emphasized that the program is divorced from producers' recommendations that tariffs on ingots be raised. Many of the members of the five allied industry associations are buyers of imported ingots.

U.S. Aluminum



The left hand scale shows the percentage of capacity. "% cap." (heavy line) indicates the operating rate of U.S. primary plants; capacity is based on data released by aluminum firms and output on Aluminum Assn. figures. "Product ship" refers to U.S. Census data on shipments of aluminum mill products and of aluminum castings — products made from secondary and imported aluminum are included. "Sheet etc. ship" refers to Aluminum Assn. data on sheet, plate and foil. "To Gov't" refers to U.S. primary aluminum shipped to the U.S. Government. Annual figures for 1953-56 are estimated; 1957-59 are public. Monthly allocation of annual amounts is based on information (not specific tonnages) then current on changes in amounts taken by the Government. Data through August, except for shipments to Government and product shipments which are through July.

Average Prices November (E&MJ Quotations)

Cents per lb unless otherwise indicated:	
Copper:	
Electro, domestic refinery	30.600
Electrolytic, exports refinery	28.005
Electrolytic, c.i.f. Cont'l ports	28.950
Lead:	
Common, New York	10.203
Common, St. Louis	10.003
Silver:	
Silver, New York, per oz.	92.313
Silver, London, pence per oz.	80.455d
Zinc:	
Prime, Western, East St. Louis	11.500
Prime, Western, delivered (g)	12.000
Tin:	
New York Straits	122.913
Gold, per oz., U. S. price	$35.000
Sterling Exchange	281.494
Quicksilver, per flask	$189.250
Antimony, (E&MJ) (d)	36.250
Antimony, bulk Laredo	32.500
Antimony, in cases, Laredo	33.000
Antimony for, 99% (h)	28.250
Palladium, troy oz.	$24.000
Platinum, refined, per oz.	$82.000
Cadmium (a)	160.000
Cadmium (b)	170.000
Al 99½% unalloyed ingot	24.000
export ingot	23.250
Magnesium, ingot	35.250
Nickel (f)	81.250
Bismuth	$2.250
Cobalt	$1.500

Domestic quotations, unless otherwise stated are in cents per lb. Sterling exchange checks, in cents. Quick-silver per flask of 76 lb.
(a) Per lb delivered, ton lots.
(b) Per lb delivered, small lots.
(d) Domestic 5 tons or more but less than carload lots, packed in case f.o.b. New York.
(f) Contract price, f.o.b. Port Colborne U.S. duty included.
(g) Delivered where freight exceeds 0.5c.
(h) 2c duty extra.

Free Gold Market

Trading volume in international markets fell 17% during the month of quiet trading, with a sudden revival of speculative purchases in the last week of the month. Volume averaged less than $1-million a day for London and Swiss centers combined; it more than doubled at the end of the month. Forward premiums for 6-month delivery remained unchanged at about 6½% p.a. for U. S. dollars and about 5% p.a. for Swiss francs. The U. S. gold stock hit another 22-year low of $16.97-billion, following an outflow of $300-million of gold during the month. Pick's World Currency Report quotes on "free gold" per fine oz as follows:

	Coins		Bars	
	Oct. 31	Nov. 30	Oct. 31	Nov. 30
New York transit	.....	.....	$35.30	$35.30
Manila	$42.55	$42.75	36.40	36.25
Hong Kong	46.65	48.15	36.70	38.75
Bombay	58.50	58.40	54.75	53.50
Beirut	41.65	40.25	35.40	35.28
Paris	42.60	42.35	35.60	35.55
Buenos Aires	42.00	41.90	35.65	35.78

Note: Prices are quoted at the free or black market value of the U. S. dollar in the local markets.

Custom Smelter Copper

Based on flat price and E&MJ average price sales in U. S. for month on November reported by American Smelting & Refining Co. electrolytic copper in standard shapes, adjusted to nearest ⅛¢; ¼¢ deducted for selling common.

Delivered consumer's plant	30.750 lb
F.o.b. refinery	30.350 lb

Major Metals

U.S. DAILY AND AVERAGE PRICES

Cents per lb unless otherwise indicated:

Nov. 1961	Electrolytic Copper (a) Domestic	(b) Export	Europe c.i.f. (c)	Lead New York	Lead St. Louis	Zinc (f) Delivered	Zinc East St. Louis	Aluminum Unalloyed Ingot 99%	Straits Tin New York
1	30.600	27.950	28.895	10.500	10.300	12.000	11.500	24.000	123.125
2	30.600	27.975	28.920	10.500	10.300	12.000	11.500	24.000	123.250
3	30.600	28.100	29.045	10.500	10.300	12.000	11.500	24.000	123.250
6	30.600	28.000	28.945	10.500	10.300	12.000	11.500	24.000	123.125
7	Holiday	28.125	29.070	Holiday					
8	30.600	28.175	29.120	10.500	10.300	12.000	11.500	24.000	122.625
9	30.600	28.000	28.945	10.500	10.300	12.000	11.500	24.000	123.625
10	30.600	28.200	29.145	10.500	10.300	12.000	11.500	24.000	123.625
13	30.600	28.050	28.995	10.000	9.800	12.000	11.500	24.000	123.250
14	30.600	27.975	28.920	10.000	9.800	12.000	11.500	24.000	122.875
15	30.600	27.875	28.820	10.000	9.800	12.000	11.500	24.000	123.125
16	30.600	27.975	28.920	10.000	9.800	12.000	11.500	24.000	123.250
17	30.600	28.000	28.945	10.000	9.800	12.000	11.500	24.000	123.375
20	30.600	28.050	28.995	10.000	9.800	12.000	11.500	24.000	123.125
21	30.600	27.925	28.870	10.000	9.800	12.000	11.500	24.000	122.875
22	30.600	28.075	29.020	10.000	9.800	12.000	11.500	24.000	122.750
23	Holiday	28.000	28.945	Holiday					
24	30.600	28.000	28.945	10.000	9.800	12.000	11.500	24.000	122.750
27	30.600	27.975	28.920	10.000	9.800	12.000	11.500	24.000	122.250
28	30.600	27.975	28.920	10.055	9.855	12.000	11.500	24.000	122.125
29	30.600	28.875	28.820	10.250	10.050	12.000	11.500	24.000	121.875
30	30.600	27.825	28.770	10.250	10.050	12.000	11.500	24.000	122.000
AVERAGES FOR MONTH									
Nov.	30.600	28.005	28.950	10.203	10.003	12.000	11.500	24.000	122.913
AVERAGES FOR WEEK									
Nov.									
1	30.600	27.975	28.920	10.900	10.700	12.000	11.500	24.000	122.050
8	30.600	28.075	29.020	10.500	10.300	12.000	11.500	24.000	123.063
15	30.600	28.020	28.965	10.200	10.000	12.000	11.500	24.000	123.300
22	30.600	28.005	28.950	10.000	9.800	12.000	11.500	24.000	123.075
29	30.600	27.965	28.910	10.076	9.876	12.000	11.500	24.000	122.250
CALENDAR WEEK AVERAGES									
Nov.									
3	30.600	27.980	28.925	10.700	10.500	12.000	11.500	24.000	122.700
10	30.600	28.100	29.045	10.500	10.300	12.000	11.500	24.000	123.250
17	30.600	27.975	28.920	10.000	9.800	12.000	11.500	24.000	123.175
24	30.600	28.010	28.955	10.000	9.800	12.000	11.500	24.000	122.875

Silver, Gold and Sterling

DAILY AND AVERAGE PRICES

Nov. 1961	Silver (c) New York	Silver London	Sterling Exchange	Gold (a) London
1	91.375	80.000d.	281.4100	250s. 1¼d.
2	91.375	80.000d.	281.4420	250s. 2¾d.
3	91.375	80.000d.	281.3800	250s. 2d.
6	91.375	80.000d.	281.3900	250s. 1½d.
7	Holiday	80.000d.	Holiday	250s. 1¾d.
8	91.375	80.000d.	281.5040	250s. 1¼d.
9	91.375	80.000d.	281.5533	250s. 1¼d.
10	91.375	80.000d.	281.5000	250s. 1¼d.
13	91.375	80.000d.	281.4700	250s. 1d.
14	91.375	80.000d.	281.5140	250s. 1¼d.
15	91.375	80.000d.	281.5520	250s. 1d.
16	91.375	80.000d.	281.5400	250s. 1d.
17	91.375	80.000d.	281.5060	250s. ¾d.
20	91.375	80.000d.	281.5725	250s. 0d.
21	91.375	80.000d.	281.6000	249s. 11¾d.
22	91.375	80.000d.	281.5700	249s. 11d.
23	Holiday	80.000d.	Holiday	249s. 9d.
24	91.375	80.000d.	281.5400	249s. 8¾d.
27	91.375	80.000d.	281.5400	249s. 8½d.
28	91.375	80.000d.	281.5060	249s. 8¼d.
29	100.750	84.500d.	281.5000	249s. 9¼d.
30	100.750	85.500d.	281.2900	249s. 11d.
AVERAGES FOR MONTH				
Nov.	92.313	80.455d.	281.494	—
AVERAGES FOR WEEK				
Nov.				
1	91.375	—	281.501	—
8	91.375	—	281.429	—
15	91.375	—	281.518	—
22	91.375	—	281.558	—
29	91.375	—	281.522	—

Calendar Week Averages: New York Silver: Nov. 3, 91.375; Nov. 10, 91.375; Nov. 17, 91.375; Nov. 24, 91.375.

THE above quotations for major nonferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis. All prices except gold and silver, are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered U.S. basis add 0.400c per pound, the average differential for delivery charges.

(b) Export copper daily quotations are weighted averages based on sales outside the U.S. reported to E&MJ. Ocean freight and 0.125c lighterage and handling are deducted to arrive at the f.o.b. Atlantic seaboard refinery quotations. On f.a.s. U.S. sales lighterage of 0.125c is deducted.

(c) The daily silver quotations reported by Handy & Harman, in cents and fractions of a cent per troy ounce, is the price paid by Handy & Harman in settlement for silver contained in unrefined silver-bearing materials submitted to them for refining. It is determined on the basis of offers of bar silver .999 fine as made to Handy & Harman for nearby delivery at New York by regular suppliers in quantities sufficient to meet daily requirements, and it is usually 0.250c below the price at which such offers are made.

The Treasury's purchase price of newly mined domestic silver is 90.5c per troy ounce 1000 fine effective July 1, 1946. London silver in pence per troy ounce, basis .999 fine.

(d) U.S. Treasury's gold price is $35. Actual payment by the United States Treasury for gold is at 99.75 per cent of the price quoted by the Treasury, which is equal to $34.9125.

(e) The c.i.f. Continental ports quotation is arrived at by adding to the f.o.b. export quotation lighterage, and the standard conference freight and insurance. Atlantic ports to main Continental ports. Currently at 0.125c and 0.82c.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingots; Cathodes are sold at a discount of 0.125c to 0.15c per pound. Quotations for zinc are based on Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High Grade zinc delivered in the East, Middle West and West effective Apr. 1, 1960, commanded a premium of 1.50c per pound over the current market for Prime Western; Special High Grade 1.75c effective Apr. 1, 1960.

(f) Prime Western delivered where freight from E. St. Louis exceeds 0.500c.

Quotations for lead are based on domestic common lead. Premiums for corroding grade have been discontinued.

MARKETS *Continued*

London Metal Exchange Quotations

Nov. 1961	Copper — Cash Bid	Copper — Cash Asked	Copper — 3 Mon. Bid	Copper — 3 Mon. Asked	Lead — Current Month Bid	Lead — Current Month Asked	Lead — 3 Mon. Bid	Lead — 3 Mon. Asked	Zinc — Current Month Bid	Zinc — Current Month Asked	Zinc — 3 Mon. Bid	Zinc — 3 Mon. Asked	Tin — Cash Bid	Tin — Cash Asked	Tin — 3 Mon. Bid	Tin — 3 Mon. Asked
1	228	228¼	228½	228¾	61¾	61⅞	62¾	62⅞	71½	71⅝	72⅝	72½	970	971	969	970
2	228¾	229	229¼	229½	62	62¼	62¾	62⅞	71⅝	71½	72¼	72¼	979	980	974½	975
3	229½	230	230	230¼	61¾	62	62⅝	62½	70⅞	71	71¾	72	976	977	971	972
6	229¾	230	230¼	230½	61¾	62	62½	62¾	71	71⅛	71⅞	72	972	973	969½	970
7	230¾	231	231	231¼	61½	61¾	62⅝	62½	70	70½	71	71½	969	970	967½	968
8	231½	231¾	231½	231¾	60¾	61	61¾	62	69½	69⅝	70¾	70⅞	967	967½	967½	968
9	231¾	232	232	232¼	60¼	60½	61	61¼	68¼	68⅝	69¾	69⅞	972½	973½	972	973
10	228½	228¾	228¾	229	59¾	60¼	60¾	60⅞	68⅝	68¾	69½	69¾	972	972½	973	974
13	229¼	229½	229½	229¾	59¼	59½	60¼	60½	68⅝	68¾	69⅝	69¾	967	968	970½	971
14	227½	227¾	227½	227¾	57½	57¾	58⅝	58¾	67½	67⅝	68⅝	68¾	961	962½	966	967
15	229¼	229½	228¾	229	58½	58⅝	59¾	60	68½	68⅝	69¾	69⅞	961	962	968	968½
16	229	229¼	228¾	229	58¾	58¼	59½	59⅝	67½	67¼	68⅝	68¾	963½	964½	970	971
17	229	229¼	228¾	229	58⅞	59½	60¼	60⅝	67⅞	68	69¼	69⅞	966	967	972½	973
20	229½	229¾	229¼	229½	58½	58¼	59⅛	59½	67⅝	67⅞	68¾	69	964	966	970	972
21	228¾	229¼	228½	228¾	59¼	59¼	60¼	60½	68¼	68⅝	69¼	69⅝	960	961	967	968
22	228¾	229	228¼	228½	59⅝	59¾	60¾	61	68⅝	68¾	69¾	70	959	960	966	966½
23	229¾	230	229¼	229½	61¾	62	62½	63	70	70¼	71⅜	71½	960	961	967	968
24	229¼	229½	229	229¼	61¾	61½	62¼	62½	70	70½	71	71½	960	961	966½	967
27	229	229¼	229	229¼	61½	61¾	62⅝	62¾	70⅝	70¾	71⅝	71⅞	955	956	961	962
28	229	229¼	229	229¼	61⅞	62	62¾	63	71⅜	71½	72⅝	72⅞	951	952	959	960
29	227½	227¾	228	228¼	61½	61¾	62½	62¼	71⅜	71½	72½	72⅝	949	950	961	962
30	228	228¼	228	228¼	60	60¼	60¾	61	70¼	70⅜	71⅜	71½	949	950	960	961
Av'g's	£229.318		£229.341		£60.398		£61.372		£69.574		£70.688		£964.284		£968.080	
Nov. avgs.	£229.6s. 4d.		£229.6s. 10d.		£60.7s. 11d.		£61.7s. 5d.		£69.11s. 6d.		£70.13s. 9d.		£964.5s. 8d.		£968.1s. 7d.	

Prices are for the official a.m. session in pounds sterling per ton of 2240 lb. Copper wire basis bars, lead 99.0%, zinc 98% and tin min. 99.7%.

Miscellaneous Metals, Ores, Minerals

Quotations cover wholesale lots, prompt shipments, f.o.b. New York unless otherwise stated. tons of 2,000 lb unless otherwise noted. st—short ton; lt—long ton; stu—short ton unit; ltu—long ton unit, (p) duty extra.

MISCELLANEOUS METALS

November 30, 1961

Aluminum ingot, 99.9% lb		26c
Antimony, spot, lb, less than carload, in cases		36.250c
In bulk, carload lots, f.o.b. Laredo		32.5c
Imported, 10 ton min. (p). 99% Duty not paid	28c —	28.50c
Bismuth, ton lots. lb		$2.25
Cadmium, ton lots delivered, lb		$1.60
small lots		$1.70
Calcium, lb, ton lots, 98%, cast		$2.05
Chromium, 99.8% grade, lb, contract delivered	$1.15 —	$1.19
Cobalt, 97 to 99%, per lb effective 3-1-60		$1.50
Germanium, per gram, 10,000 gram lots	(d)28.15c—(c)(d)29.95c	
Indium, troy oz	$1.50 —	$1.80
Lithium, lb, 98%	$9.00 —	$11.00
Nickel, cathodes, lb (a)		81¼c
Other sales, regular sellers		81¼c
Sales by dealers, etc.		81¼c
Magnesium, 99.8% carloads, lb producer's plants, Velasco, Texas, effective Apr. 16		35.25c
Palladium, troy oz	$24 —	$26
Platinum, troy oz	$80 —	$85
Quicksilver, flask of 76 lb. 25 flasks or more	$190 —	$193
Selenium, 99 plus %, lb—(Feb. 19, 1958)	$6.50 —	$7.50
Silicon, minimum 98%, carloads, lb		19c
Hyper-pure; rod per kilo	$385 —	$407
Tellurium, lb		$5.25
Thallium, 100 lb or more		$7.50
Titanium, 99.3% plus, grade A-1, max. 3% Fe, lb (b)	$1.50 —	$1.60

(a) Effective July 1, 1961; including U. S. duty; (b) Effective Aug. 1, 1959. (c) Delivered; (d) f.o.b. plant.

METALLIC ORES

Beryllium ore, imported, 10% BeO, (b) stu; spot	$32 —	$33
term contracts	$34 —	$34.50
Chrome ore per long ton, f.o.b. cars Atlantic ports, dry:		
44% Cr_2O_3 no ratio	(a)$19.75 —	$20.50
48% Cr_2O_3 3 to 1 ratio	$35¾ —	$38
Iron ore, Lake Superior, Lower Lake ports, lt		
Old Range bessemer		$11.85(e)
Mesabi bessemer		$11.60(e)
Mesabi non bessemer		$11.45(e)
Manganese ore—Per ltu of Mn basis 48%, nearby positions, subject to premiums and penalties, c.i.f. U. S. ports import duty extra., (n)87c—90c. Long-term contract nominal.		
Molybdenum ore, 90%, per lb of Mo f.o.b. mines		$1.40
Columbian-Tantalum, per lb, combined oxides 10 to 1 ratio	$1.18 —	$1.25
Tungsten ore, per stu of WO_3:		
Foreign 65%, c.i.f. U. S. ports, duty extra	$16.00 —	$16.50
U. S. scheelite, f.o.b. mill	$22 —	$24
Vanadium ore, per lb of contained V_2O_5 f.o.b. mines		31c
Zinc ore, Prime, 60% concentrate, Joplin, Mo., per ton.		$68

(a) Nominal. (b) c.i.f. U. S. ports. (e) Effective 1958 shipping season.

METALLIC COMPOUNDS

Arsenous oxide (arsenic trioxide) lb, in bbl, carload lots N. Y. docks		4c
Cobalt, oxide, 72½% to 73½%, per lb, effective Mar. 1, 1960	$1.15 —	$1.18
Copper sulphate, 100 lb, effective 5-17-61		$12.50
Germanium dioxide, gm		16¾c
Molybdic trioxide, technical, per lb of Mo	$1.59 —	$1.60
Imported, including 37c duty	$1.75 —	$2.05

ALLOYS

Ferrochrome 58 to 65%, per lb of Cr. (4¼% C)		24c
Ferromanganese, 74 to 76%, per lb shipping point		11c
Ferromolybdenum, 58 to 64% Mo., lb of Mo contained.	$1.63 —	$1.95
Ferrosilicon, 50% per lb of Si f.o.b. shipping point		14.60c
Ferrotungsten, 70 to 80%, lb of W contained		$2.45
Ferrovanadium, per lb of V delivered	$3.20 —	$3.40
Silicomanganese, max., 1¾%C, lb contracts		11.6c
Spiegeleisen, per lt, 19-21% grade	$98 —	$101

NONMETALLIC MINERALS

Asbestos, f.o.b. Canada (Quebec) mines (Canadian funds) ton:			
Crude No. 1	$1,400–$1,725	Paper stock	$120–$142
Crude No. 2	$750–$1,155	Waste	$75– $86
Spinning Fibers	$370– $600	Shorts	$40– $75
Shingle fibers	$180– $220		
Asbestos, f.o.b., Vancouver, B. C. (Canadian funds):			
Crude No. 1	$1,522	Spinning fibers	$470–$787
Asbestos, Vermont, f.o.b. Morrisville:		Shingle fibers	$142–$325
Spinning fibers	$353– $408	Waste, stucco or plaster	$86
Shingle stock	$181– $218	Refuse or shorts	$41– $75
Paper stock	$120– $142		

Barytes, f.o.b. cars:		
Georgia, crude, per ton		$18
Missouri, 94%, $BaSo_4$, per st	$16 —	$18
Crude oil well grade, min. 4.3 sp gr, st (a)		$18
Imported, c.i.f. Gulf Ports, st	$12½ —	$14
Bauxite, st, f.o.b. point of shipment: Imported metallurgical, per lt, f.o.b. Br. Guiana, 60% Al_2O_3, 6% SiO_2, 1.25% Fe, 1-1-60		$7.25
Feldspar, bulk ton, f.o.b. plants:		
Potash or soda feldspar, 200 mesh, ceramic grade	$17 —	$20.50
Glass feldspar, white, 20 mesh		$9
Fluorspar, f.o.b. mines, bulk, 72½% effective, ton	$37 —	$41
60% effective CaF_2	$33 —	$36
Acid 97% concentrate, bulk, ton f.o.b. Ill.	$45 —	$50
Fuller's earth, f.o.b. Georgia or Florida, ton	$7.00 —	$14.00
Magnesite, per ton dead-burned, bulk, f.o.b. Washington		$46

Mica—Domestic, f.o.b. mines. Punch 7c-12c per lb according to size and quality. Sheet clear 1½x2 in. 70c-$1.10; 2x2 in. $1.10 to $1.60; 2x3 in; $1.60-$2.10; 3x3 in. $1.80-$2.30; 3x4 in. $2.00-$2.60; 3x5 in. $2.60-$3.00; 4x6 in. $2.75-$4.00; 6x8 in. $4.00-$8.00, Wet ground, very fine, $140-$155 per ton. Bulk sales, dry ground; $30-55 per ton. Scrap $20-$30.

Ocher, Georgia, ton in sacks	$26.50 —	$32.00
Sulphur, Mexican, for use in Mexico, metric ton, f.o.b. mines, depending on location	$21 —	$23
For export f.o.b. vessel, depending on grade	$22.50 —	$23.50

Actual prices received by U. S. producers approximate the Mexican export prices.

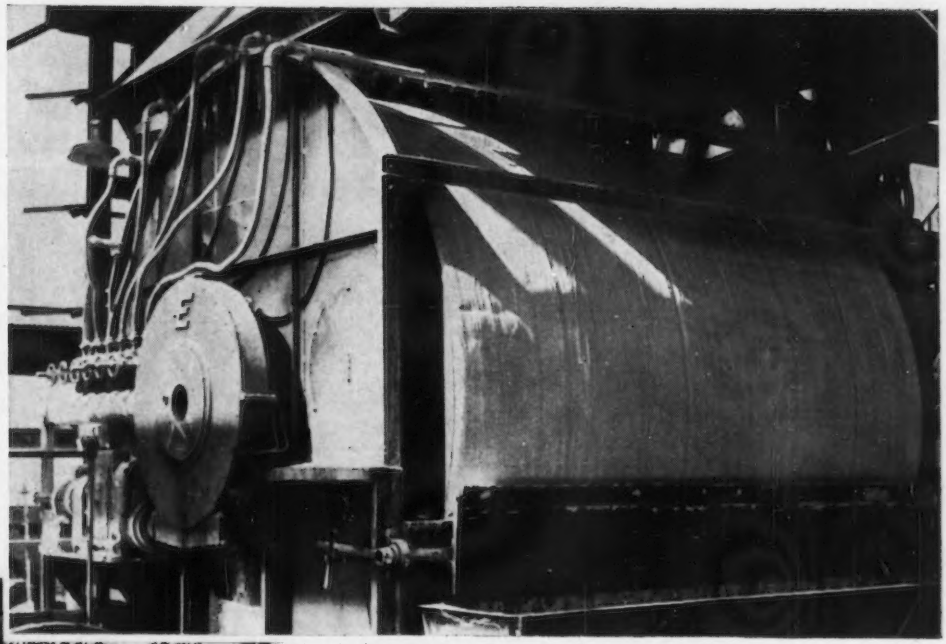
Talc, f.o.b. works, ton:		
New York, purified	$18.00 —	$20.00
Vermont, extra fine		$12.50
Tripoli, Missouri, ton:		
40-mesh, cream colored		$50.00

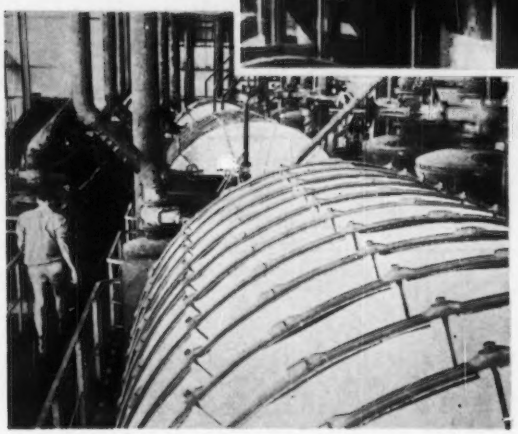
(a) Some restricted sales at $11.50; (b) Corrected; (c) Nominal.

IRON AND STEEL

Pig iron, gross ton, basic, Valley furnaces		$66.00
Steel, f.o.b. Pittsburgh, billets, net ton		$80.00
Structural shapes, Pa., Ala., etc., 100 lb	$5.30 —	$5.50

13 EIMCO Filters at FRIA





Handle Record Tonnages in New African Plant

FRIA, an organization owned by Pechiney, France; Olin, U.S.A., and several other European aluminum companies, operates one of the world's largest alumina plants in West Africa. The huge plant employs 13 Eimco filters.

A battery of 11½-ft diameter by 12-ft. Eimco drum filters dewater and wash final alumina tri-hydrate crystals. Each is equipped with special multiple wash headers, for highest washing efficiency, and streamlined Eimco Hy-Flow valves for handling an exceptionally high flow with negligible hydraulic loss. An E-Vac air sweep, built into each filter's hydraulic system, eliminates filtrate blow-back, assuring low cake moistures.

The high performance achieved by these filters is a result of cooperative engineering in pilot plant and design stages. FRIA and Eimco engineers worked as a team on equipment design, were guided by past experience in engineering equipment for similar difficult filtration problems.

For the FRIA process, seven 12½-ft. by 12 disc Eimco Agidisc filters were custom-designed for handling huge volumes of caustic liquor, in dewatering hydrate seed. Eimco Hy-Flow valves enable these filters to dispatch the required flow with minimum hydraulic loss.

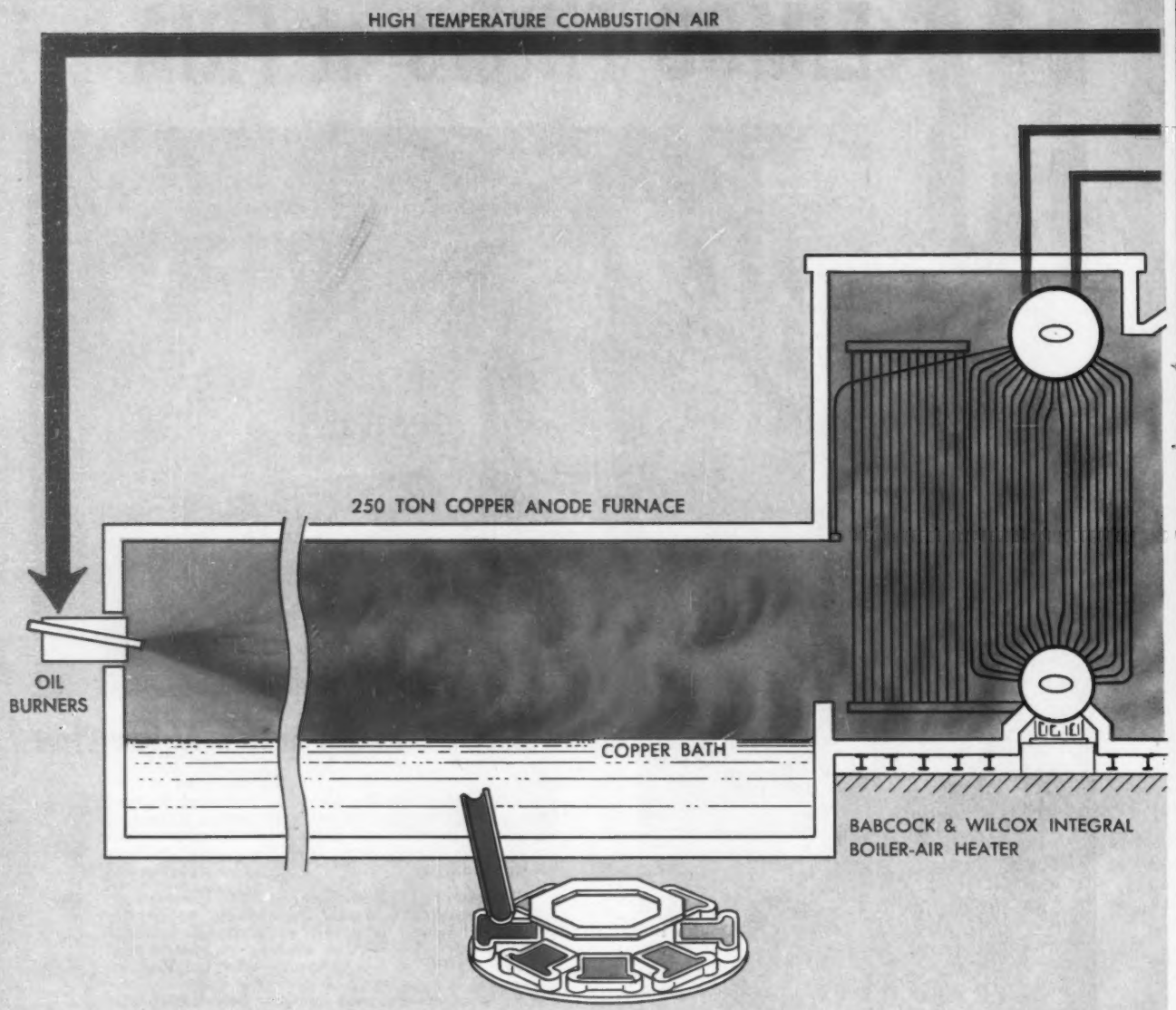
Hy-Flow, E-Vac and Agidisc are trademarks of The Eimco Corporation.

Ask your nearby Eimco representative for details.

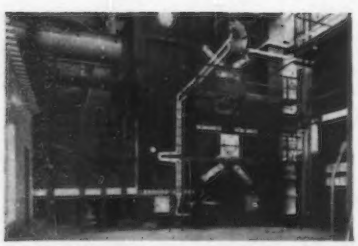
Write The Eimco Corporation,
Salt Lake City 10, Utah, U.S.A.
for Bulletin FC-2049.

EIMCO
"Advanced Engineering and Quality Craftsmanship Since 1884"

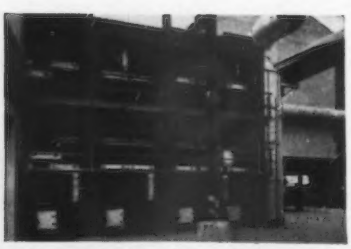
B-846



B&W integral boiler-air heater increases copper production



B&W waste heat boiler conditions flue gas for air heater and produces enough steam for plant base load requirements.

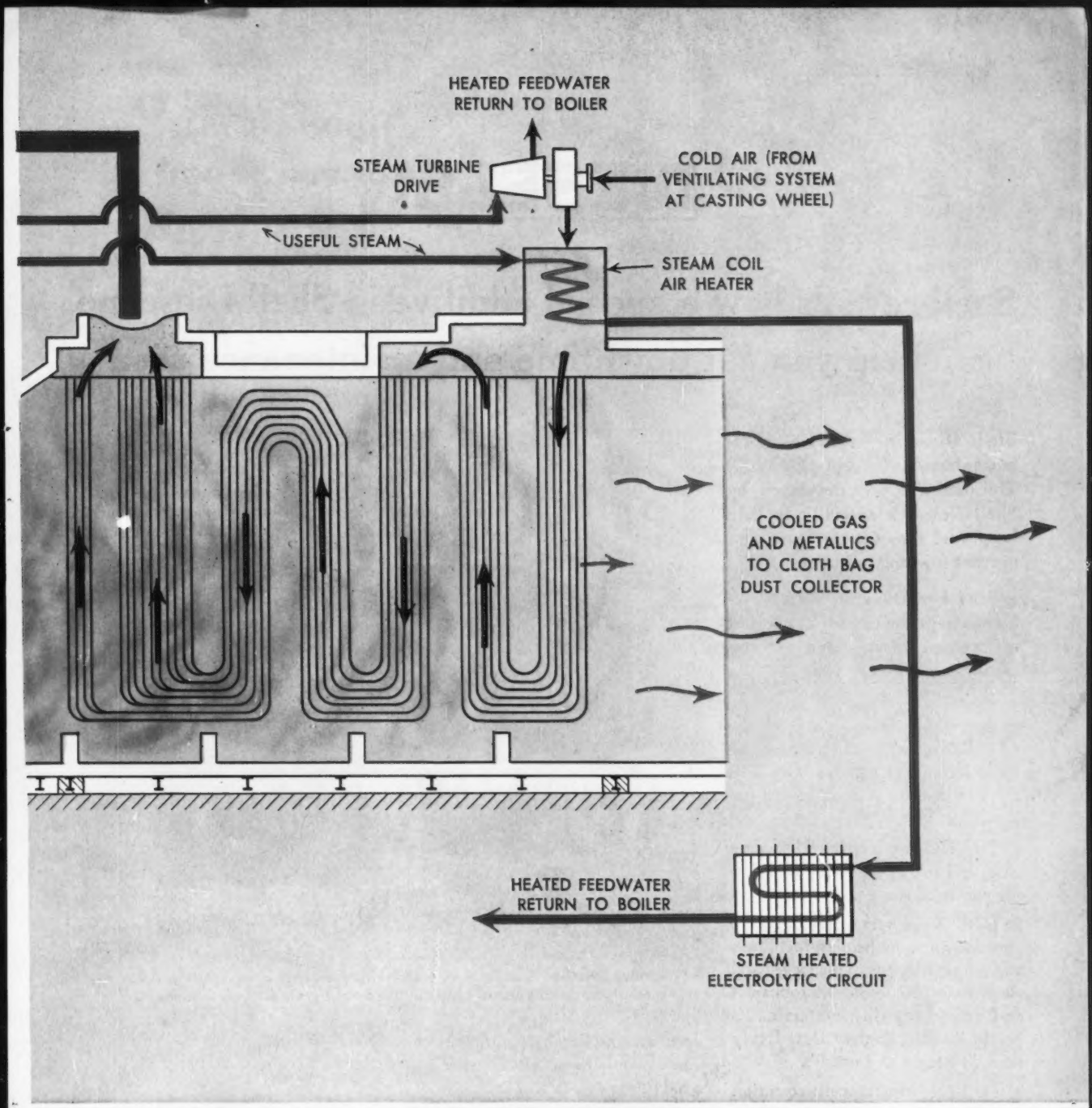


B&W air heater heats combustion air for copper anode furnace and cools flue gas for zinc oxide recovery.

Lewin-Mathes Co., a division of Cerro Corp., recently installed a copper anode furnace at their Monsanto, Ill. plant where refined copper and tubing are produced.

Flue gas from this furnace is highly corrosive with high solids carryover. It rapidly clogs conventional heat recovery units.

Babcock & Wilcox's solution to this problem is an integral waste heat boiler-air heater which pro-



and cuts operating costs for Lewin-Mathes Company

duces maximum useful heat recovery from process waste gas.

The B&W waste heat boiler conditions the flue gases, leaving only dry dust particles which flow freely through the air heater. Enough steam is generated to fulfill the plant's base load requirements.

Maximum furnace efficiency is achieved with high temperature combustion air from the air heater. Using B&W's extensive experience in heat transfer apparatus, the air heater is the reverse of usual design. Combustion air flows through the tubes; gas over the tubes. Gas side deposits are effectively removed through lance doors located for complete coverage of tubular surfaces.

Copper alloy tubing, produced by Lewin-Mathes, is used in the final section of the air heater. In this highly corrosive, low temperature gas zone, steel tubing would rapidly corrode. Copper tubing has performed exceptionally well.

After cooling, exit gas is sent to a bag collector where zinc oxide is recovered and clean gas discharged.

For help in solving your heat recovery problems, call your nearest B&W representative or write: The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

Babcock & Wilcox

DIESELS:

Shell reveals how a special additive in Shell Dieseline can help you cut downtime and maintenance costs

Shell Dieseline® contains a remarkable additive called FOA-5X®. This additive was developed by Shell Research specially to help keep fuel line filters clean, and prevent injector corrosion.

Read how Dieseline with FOA-5X can help you cut downtime and maintenance costs—and get top engine performance.

SHELL Dieseline contains a special additive called FOA-5X®. Here are three important moneysaving jobs FOA-5X does for your diesel fuel systems.

1. FOA-5X helps keep Shell Dieseline clean and free of sediment, even during prolonged storage.

2. FOA-5X can help reduce diesel engine downtime by helping fuel filters and injectors to remain unclogged and clear. It inhibits sediment formation and helps keep tiny contaminants finely divided so they flow freely through screens and nozzles.

3. FOA-5X helps prevent corrosion and rust.

Maximum economy

The uniformity of Shell Dieseline enables injector nozzles to work efficiently. And it lets your mechanics tune an engine's fuel injection system for maximum economy.

The viscosity of all Dieseline is controlled to help provide proper lubrication of pumps and injectors.

Minimum knock, fast starting

The ignition quality, measured by cetane number, is tailored to your engine requirements. Results: controlled combustion, minimum diesel knock and good starting characteristics.

Shell Dieseline can help produce maximum engine power. And can make a significant difference in your diesel equipment. That difference is *top engine performance.*

Grades for all engines

Shell Dieseline is available coast to coast in grades to meet all engine requirements.

How to learn more about Dieseline

For additional information on Shell Dieseline, contact your Shell Industrial Products Representative. Or write: Shell Oil Company, 50 West 50th Street, New York 20, N. Y.

Shell Dieseline is available in grades to meet all engine requirements. Ask your Shell representative to specify the correct grade for your equipment.

SHELL

A Bulletin from Shell
—where 1997 scientists are working to provide better products for industry

"4-in-1 actions do 'most any job... Fast and Efficiently"

Supt. Wm. Hagedorn, George L. Rack, Inc., Cincinnati, Ohio

George L. Rack, Inc., produces washed sand for masonry, asphalt plants, and fill—also supplies topsoil and playground clay to various markets. Their International Drott TD-20 Four-in-One strips raw materials; loads out both raw and finished materials; builds and maintains pit roads; cleans-up around the washing plant.

"Our 4-in-1 gives us a single rig with unlimited versatility," states William Hagedorn, Plant Superintendent. "Four-in-One bucket actions enable the operator to do 'most any job, fast and efficiently. After our six years of 4-in-1 experience, we wouldn't even consider the other type of bucket."

Prove what it means to get mine-and-quarry-proved **loader, 'dozer, clamshell,** and **"carry-type scraper"** actions—all in one big-capacity rig. See your International Drott Distributor for a 4-in-1 demonstration.

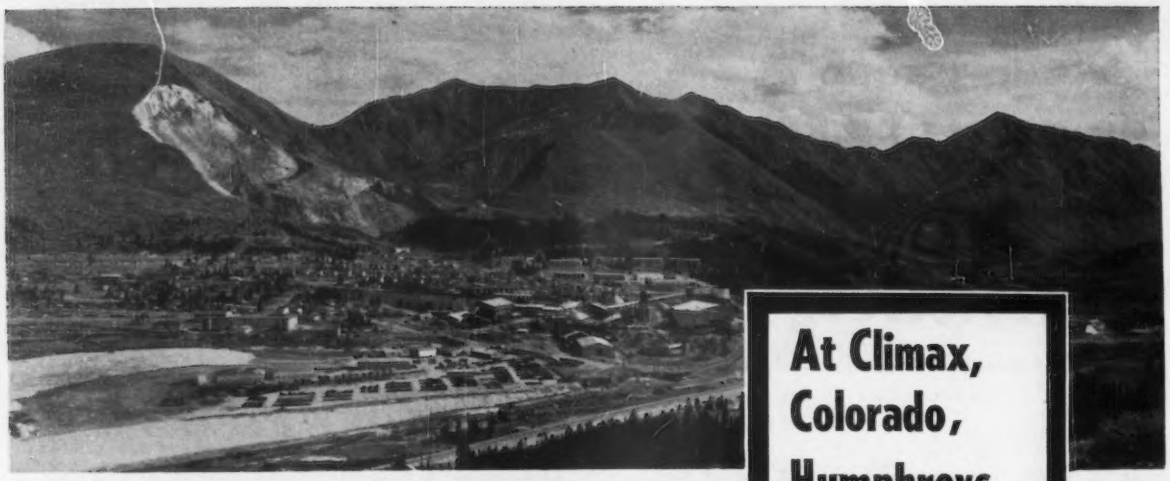
International Harvester Company, Chicago 1, Illinois
Drott Manufacturing Corp., Milwaukee 15, Wisconsin

INTERNATIONAL® DROTT®

Clearing out a build-up of mucky, clay-type washing plant waste for easy loading and removal—note how the Rack company's operator uses clam back-drag action, pulls down the material fast, to speed work that "stumps" non-clam buckets!

Sticky, mucky materials that plug "lockjawed" buckets, waste time and run up costs, don't slow down the 4-in-1. Reason: exclusive, positive self-cleanout bottom dumping. Opening the clam pulls the material from bucket surfaces—gravity downpull does the rest and keeps the cycle rhythm!

For full-size, full-capacity bulldozer action, the operator simply "touch controls" the 4-in-1's front segment up—positions the blade segment—and rolls the earth like a specialized 'dozer!



At Climax, Colorado, Humphreys Spirals Recover Tungsten, Tin and Pyrite from Flotation Tailings

After Molybdenum concentration by flotation, ...

HUMPHREYS SPIRAL CONCENTRATORS

take over the processing of 33,000 tons of flotation tailings daily for the recovery of minor, but valuable by-product tungsten, tin and pyrite.

The success of this by-product plant is made possible only because of the efficiency of Humphreys Spirals—low capital cost—low operating cost, low maintenance cost coupled with metallurgical efficiency.

Humphreys Spiral Concentrators have world-wide application and acceptance for the recovery of minerals in the range of 8 mesh to 325 mesh and finer. Our engineers and our laboratory facilities can be valuable to you in determining if there is a proper application for Humphreys Spirals in your plant.

HUMPHREYS ENGINEERING CO.

Suite 910 American National Bank Bldg. • Denver 2, Colorado • Phone AComa 2-4577

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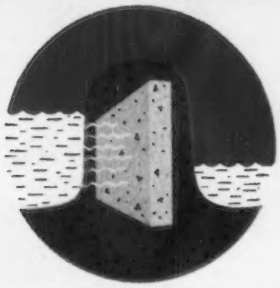
SYDNEY, AUSTRALIA

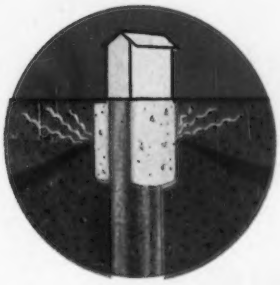
The General Electric Co. Ltd.
(Fraser & Chalmers Engineering Works)
ERITH, KENT ENGLAND

HOW HALLIBURTON GROUTING VERSATILITY SOLVED THESE PROBLEMS



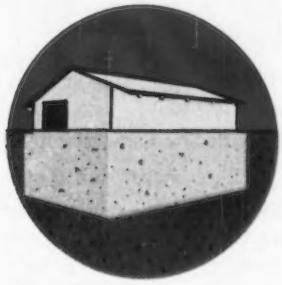
WATER RESERVOIR LEAKAGE

Irvine, Ky. – A reservoir adjacent to the Kentucky River was losing considerable water through permeable stratum beneath the reservoir dam. SOLUTION: Halliburton Pressure Grouting Service was engaged to build a cutoff "wall" through the permeable stratum. Grouting holes were drilled into the permeable stratum. Halliburton DOC (Diesel Oil Cement) grout was selected because of its ability to set almost immediately when contacted by water. Water leakage from the reservoir was completely halted.



SALT MINE WATER INTRUSION

Avery Island, La. – The wall of this 15′ x 20′ ventilation and access shaft, 508′ deep, is formed of open salt except for a concrete caisson lining the top thirty feet. Water had dissolved the salt behind the concrete at the caisson base, allowing water intrusion into the shaft. The water was dissolving and eroding the walls all the way to the mine floor. SOLUTION: Halliburton studied the problem and simulated these subsurface conditions for a long series of experimental injection tests prior to presenting a grouting plan for approval. It was decided to inject Halliburton Bloxall chemical grout at unusually low pressures and volumes to effect a water-tight seal between the salt dome and overburden without adversely affecting the salt, and to consolidate the fine water-bearing sand surrounding the shaft. Two concentric perimeters of grouting holes were drilled around the shaft. Pipe was placed in the holes and perforated at carefully selected depths with Halliburton's perforating tool. Accurate injection pressures were maintained at exacting levels by Halliburton's versatile six-plunger grouting pump. Pressure tests and observation after the job determined that the shaft was dry following this treatment and indicated that the surrounding formation was consolidated.



COMPRESSOR STATION VIBRATION

Wichita, Kan. – Excessive vibration in this compressor station building and surrounding area was apparently being caused by harmonic action of the compressors plus the inability of loose sand underlying the foundation to adequately anchor the structure. SOLUTION: A pattern of grouting holes were drilled through the floor of the building and into the unconsolidated sand formation. Halliburton Chemical grout was selected because it was necessary to actually penetrate the pore spaces of the loose sand. Following the chemical grout placement through perforations, the loose sand was consolidated and tied together, thus eliminating the damaging effects of vibration on equipment and protecting gas lines leading into the building.

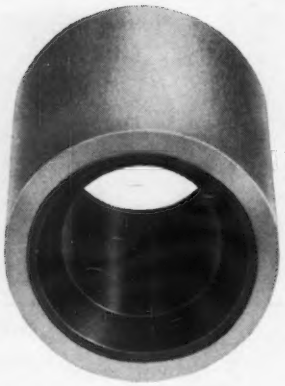
CONSULT YOUR HALLIBURTON GROUTING SPECIALIST for more details on helping you solve these and many other difficult problems with the advanced techniques of Halliburton Pressure Grouting Services. He is as near as your phone.

Halliburton is fully qualified to perform any size grouting operation as a prime or sub-contractor

PRESSURE GROUTING SERVICES

Halliburton
COMPANY · DUNCAN, OKLAHOMA

YOU'LL NEVER HAVE TO FORGE ANOTHER COLLAR ON A DRILL STEEL!



New LeRoi rubber-lined drill steel collar

We repeat: You'll never have to forge another collar on drill steel! What's more, steel costs drop when you use the new Le Roi Rubber-Lined Drill Steel Collar.

This latest Le Roi exclusive is a sturdy steel collar with an annular rubber lining integrally bonded inside the outer steel body. It is as easy to use as it is revolutionary. You simply apply a bonding compound to a clean drill shank and the inner collar surface, push the collar down over the end of the steel, and let set for 24 hours. The results: A tough shock-absorbing collar without distortions and weakening heat notches — and complete elimination of costly forging and heat-treating. And it will never come off!

The vise-like but resilient collar dampens harmonic shock waves, thereby providing longer steel and bit life. You discard steel because it wears out, not because it breaks. You merely form the taper or thread on the drill rod and attach the bit. Heat-treating is *out!*

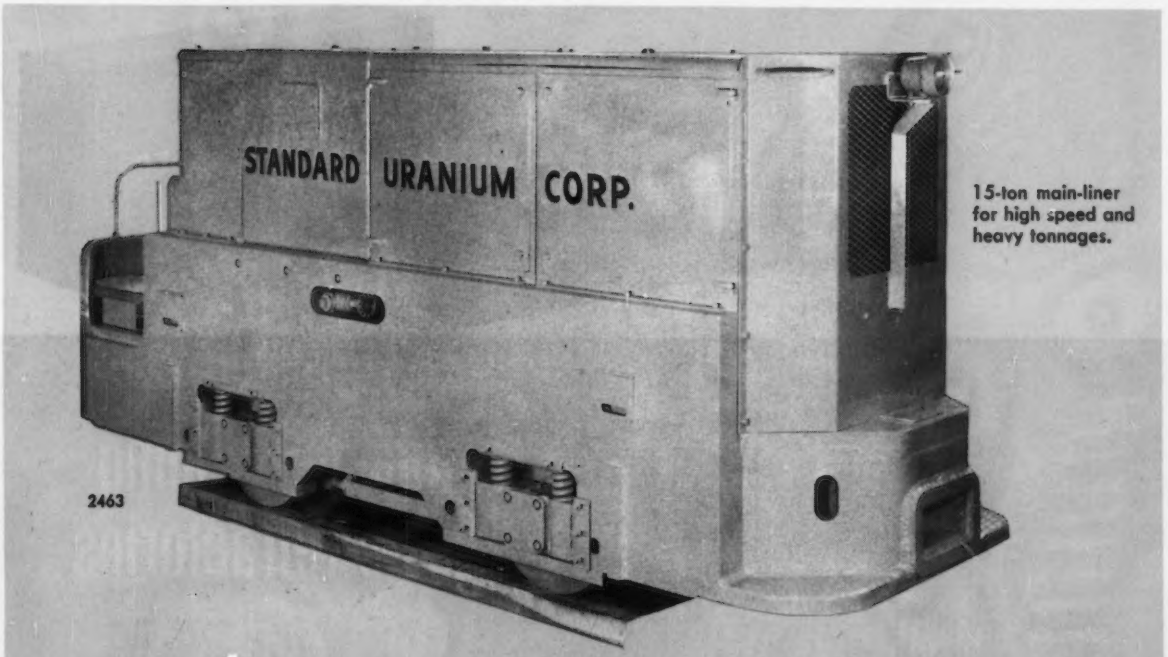
There's more. Since there's no upsetting of the steel, you eliminate distortion of the water flushing hole. Rethreading and retapering are held to a bare minimum. And you can slash your protective inventory and the reworking of broken steel.

The Le Roi Rubber-Lined Drill Steel Collar Kit makes forge-collaring as obsolete as the village smithy. Ask your Le Roi Distributor for details, or write to Le Roi Division, Westinghouse Air Brake Co., Sidney, Ohio.

AT-107

LE ROI NEWMATIC AIR TOOLS

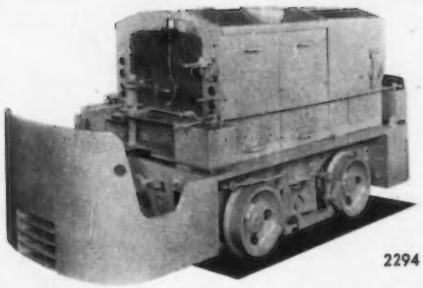
PORTABLE AND TRACTAIR® COMPRESSORS • STATIONARY COMPRESSORS • AIR TOOLS



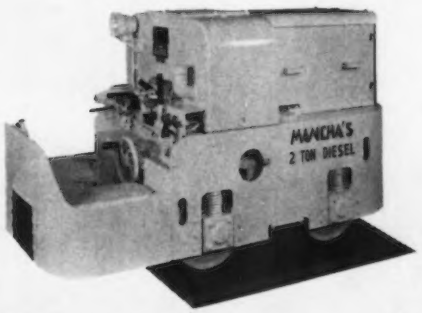
15-ton main-liner for high speed and heavy tonnages.

Mine or tunnel, heavy loads or light

MANCHA diesels can do it!



A 6-ton unit for hauls from remote areas where trolley or battery locomotives are impractical.



2-ton trammer for light duty in small mines and tunnels. 2306

No matter what your haulage job—mine or tunnel, heavy loads or light—Mancha's highly efficient, cost-reducing, diesel-powered locomotives are engineered to help you do it better. All models are designed to minimum dimensions. Operation is simple. Accessibility for routine maintenance easy. Job life excellent, 24-hour service assured.

In addition, with Mancha you can benefit from our engineering service—which you'll get without cost or obligation of any kind. Based on their experience, our engineers will make recommendations to give you the best haulage efficiency at the lowest possible cost.

Whether you're in the market today or will be in the future, you should know about the economies you can expect from Mancha diesel-powered locomotives. Wide range of sizes . . . from 2 tons to 20 tons operating weight.

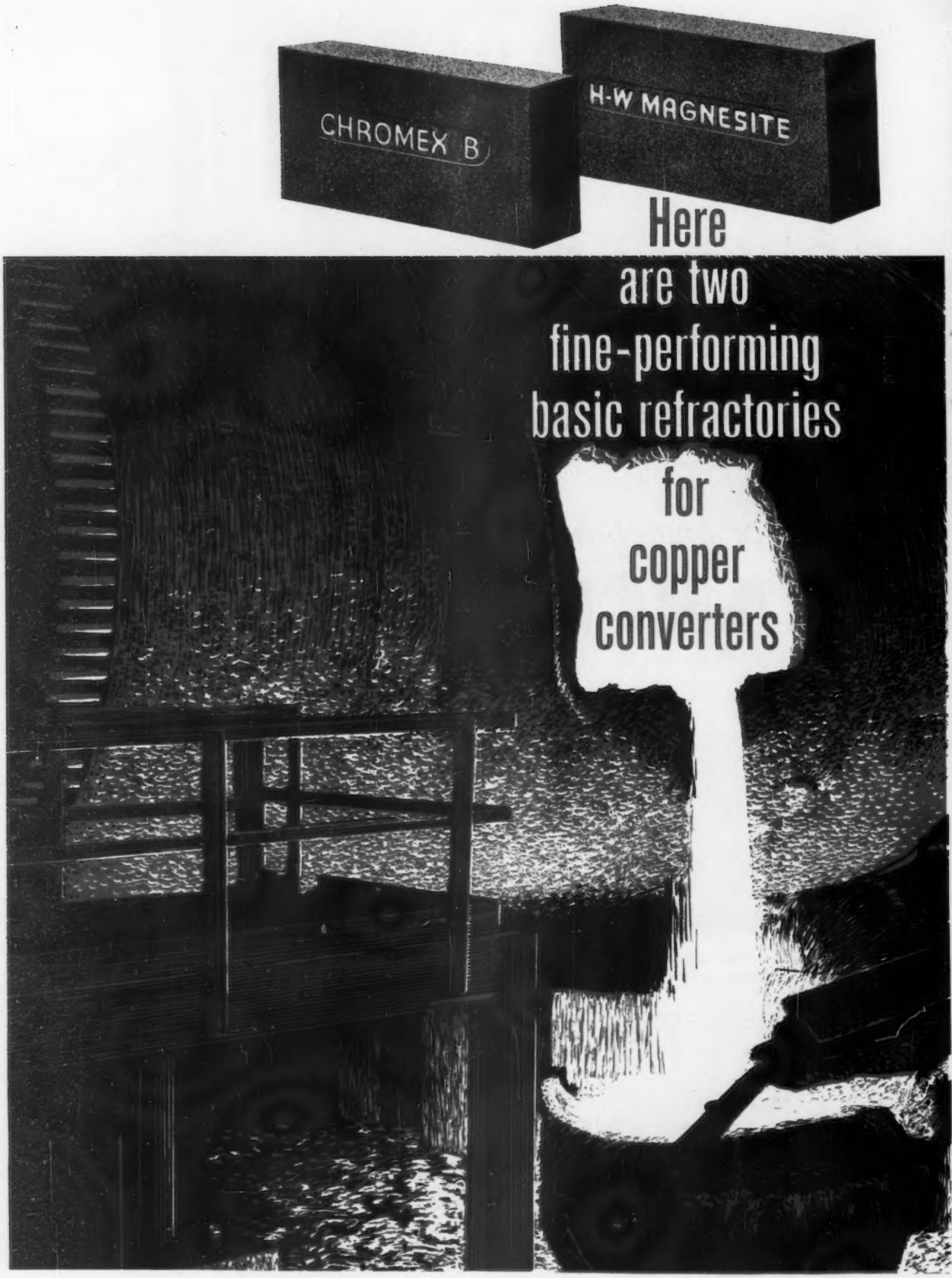
MANCHA LOCOMOTIVE

DIVISION GOODMAN MANUFACTURING COMPANY

Halsted Street and 48th Place • Chicago 9, Illinois

Cable Address: Mancha, Chicago

Mancha representatives are located in principal mining areas throughout the world.


CHROMEX B
H-W MAGNESITE
Here
are two
fine-performing
basic refractories
for
copper
converters

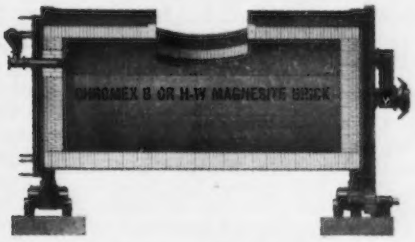
CHROMEX B is an extra hard-burned chrome-magnesite brick with high density and low permeability . . . good resistance to thermal shock . . . unusual stability and high strength at high temperatures.

H-W MAGNESITE is a superior hard-burned refractory, consisting predominately of periclase (stabilized crystalline magnesia), for the most severe requirements of copper converters. It is dense, strong and volume stable at temperatures far above the highest employed in copper converters.

These quality-controlled Harbison-Walker basic refractories are used also with great benefit in longer life for parts of copper reverberatory smelting and refining furnaces.

INCREASED PRODUCTION... EXTENDED SERVICE LIFE... REDUCED OPERATING COSTS

Contact Harbison-Walker Technical Service Department for complete application details.



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World's Most Complete Refractories Service

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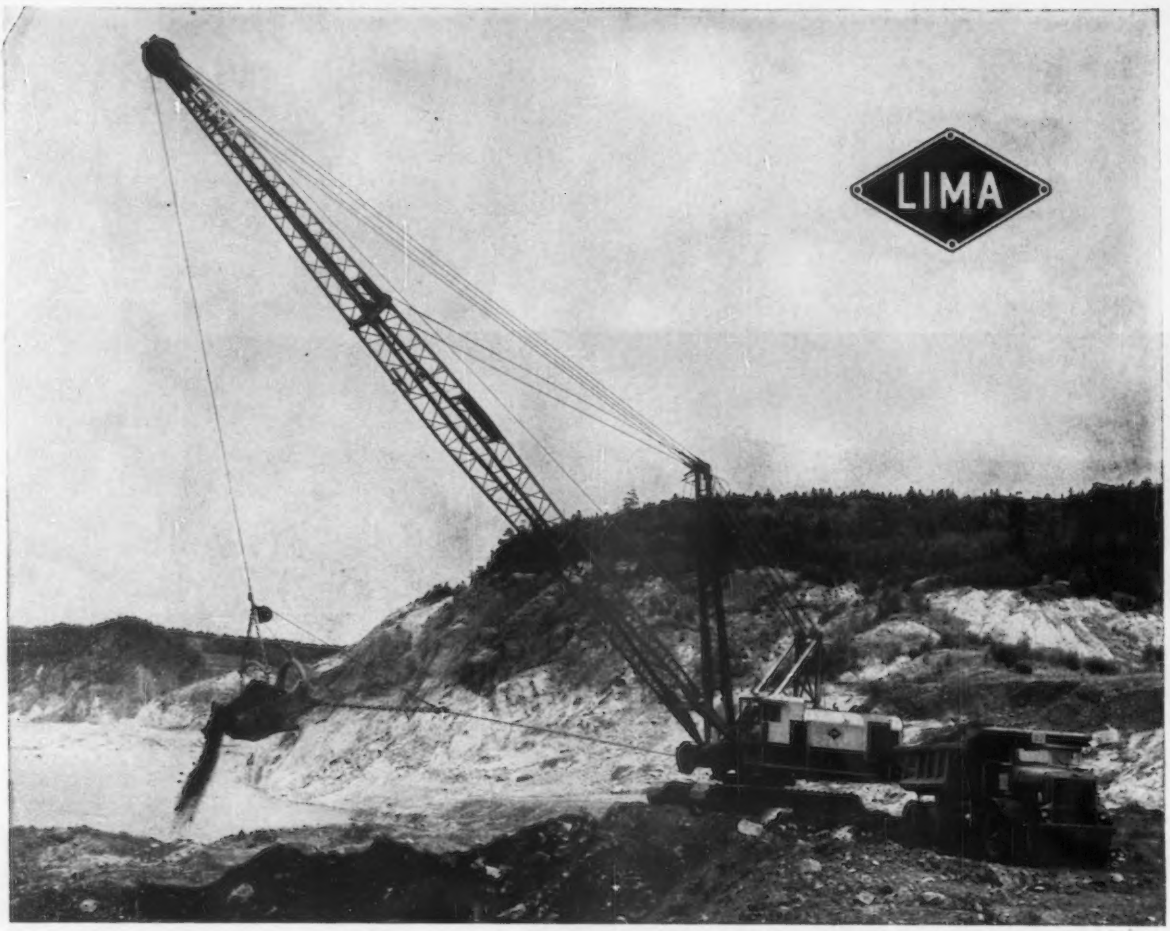
HW 61-23



Lima Type 2400 dragline speeds iron ore stripping operations.

Limas dig, strip or load more . . . for less cost!

It takes a rugged breed of men and machines to mine the ores deposited so willfully around the globe by nature. Limas are part of that special breed. For wherever mining jobs call for more digging, stripping and loading capacity . . . at less cost . . . you will find Limas doing more than their share of the work.

Muscled for big jobs

The Lima Type 2400 is muscled for the really big mining jobs—as a variable capacity dragline, 8 cu. yd. shovel, or 110-ton crane. It is mounted on wide and long crawlers for extra ground contact and easy handling. Large-diameter drums are extra wide for increased cable capacity.

Anti-friction bearings reduce wear at all important bearing points. Large air-operated clutches give instant response to controls. Torque converter increases output, reduces shock loading, prevents engine stall, gives cables longer life, and lowers maintenance.

Lima quality pays

These are only a few of the many quality features that pay off for you with a Lima. As hundreds of mining operators have found, Lima's extra engineering features and built-in quality mean greater tonnage and higher profit.

There is a Lima type and size for every mining operation! Shovels ¾ to 8 cu. yds., variable capacity draglines, cranes to 140 tons. Get full information today from your nearest Lima distributor on powered-for-profit Limas—or write to us.

This team of hard working Lima shovels speeds Mesabi Range ore loading. At left, 1½ cu. yd.; at right, 3½ cu. yd.

DISTRIBUTORS IN PRINCIPAL CITIES OF THE WORLD

LIMA Construction Equipment Division, Lima, Ohio

BALDWIN · LIMA · HAMILTON

6105

Shovels • Cranes • Draglines • Pullshovels • Roadpackers • Crushing Equipment • Asphalt Plants

"Only Payhaulers dare move full loads down this 38% grade!"

Exclusive Torqmatic brake lets International Payhaulers speed full 27-ton loads down the mountain —a dangerous trip in any other rig. Early in the job, when this steep grade was too much for other haulers, six 95's kept production going. This is the toughest section of Slate, Hall & Hamilton's $8,000,000 roadbuilding contract.

Other rigs sit idle while "95" Payhauler units move 27-ton loads down mile-long haul road...

Slate, Hall & Hamilton of Portland are building 4-lane US Route 5 through Oregon's rugged coastal range. Contract calls for moving 4,800,000 cu. yds. of 20% rock material. Toughest part of the job is 330-ft. cut through high rocky outcrop above the Sacramento River. Existing Route 99 and main line of Southern Pacific Railroad—both kept open—run between the job and the river. Haul roads, crowded against the cliff, are steep and narrow, with hairpin curves.

"I wish we had more Payhaulers on this hill," says Owner E. D. Slate. "They took out full loads on a mile-long road with a 38% grade where we didn't dare put other trucks. Even after we cut the maximum grade to 28% other rigs only carry half a load. Thanks to that Torqmatic brake, we're getting full production from the Payhaulers!"

Downgrade hauling stability is built right into the Payhauler. Positive Torqmatic braking, standard equipment on the 95, gives the operator confidence to use best haul speeds, even on the steepest grade with a full load. Fingertip power steering and convenient brake control lever further increase operator ease and safety—add up to extra haul cycles on every job. Prove to yourself how the 27-ton 95 or the 19-ton 65 will boost production on your spread. Call your International Construction Equipment Distributor and arrange for a Payhauler demonstration today!

International® *Construction Equipment*

International Harvester Co.,
180 North Michigan Ave., Chicago 1, Illinois
A COMPLETE POWER PACKAGE

Where you need top truck performance

MACK SHOULDERS

We built it and we stand behind it 100% — Who else can say the same?

MADE BY MACK • • •

THE RESPONSIBILITY

Mack can provide you with top truck performance—performance unmatched by any other truck—because what goes into a Mack is *made by Mack*... has the full backing of Mack. Engines, clutches, transmissions, axles, drives and all other major components are made by Mack for Mack trucks alone... made to the highest standards of the industry to work together with maximum efficiency.

The perfect integration of components achieved by Mack results from the exclusive concept called Balanced Design. It is the basic reason why Mack—alone among truck manufacturers—does not have to split responsibility for its truck performance with outside suppliers of major components.

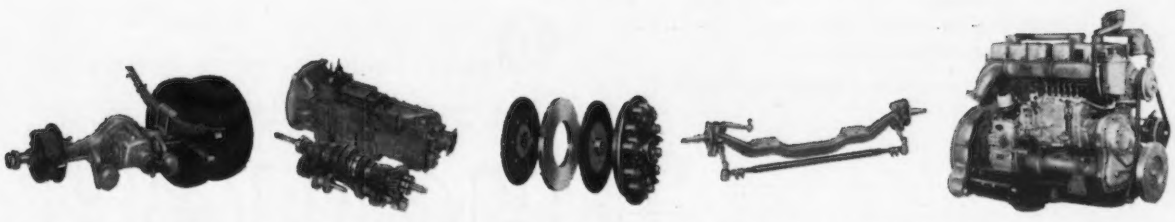
This is Mack's way of making sure you always get unqualified satisfaction... of being sure that every Mack on your job gives the best possible truck performance and maintains the longest prime of life.

So, whether you're hauling freight... building an expressway or moving rock... delivering furniture, fuel oil or ready-mix concrete... if it's the kind of work that means handling big loads at a profit—it's the kind of work for Macks.

Mack trucks on your jobs will give you the advantage of lowest cost of operation plus undivided responsibility for full satisfaction. Your nearest Mack branch or distributor will be glad to suggest the exact model to handle your jobs with utmost dependability and efficiency. Mack Trucks, Inc., Plainfield, New Jersey. Mack Trucks of Canada, Ltd., Toronto, Ontario.

IT'S PART OF THE LANGUAGE... BUILT LIKE A

Mack



MADE BY MACK • • • MADE BY MACK • • • MADE BY MACK • • • MADE BY MACK • • • MADE BY MACK

No. 5 in a series of announcements on new **HOUGH** *machines*

This new 60-ton tractor is so different there is

nothing like it

in design, or in performance on push-loading and dozing work

For two years on several multi-million-yard earth-moving jobs a new idea in push-loading has been under extensive and sustained operation behind a variety of scrapers. This new idea is the HOUGH D-500 PAYDOZER — a different and better kind of rubber-tired pusher and dozer as shown by its performance on these projects.

More Power. A 700 hp turbo-charged V-12 Cummins diesel is governed to 2100 rpm and 600 hp for longer life and lower maintenance. Two newly-developed, high-efficiency dry-type air cleaners plus filtration of all oil circuits are provided.

Articulated Hydraulic Steering is one of the most unusual features and gives exceptional maneuverability. The turning radius is under 25-ft.—considerably less than its overall length and one-third less than a comparable unit with rear-steer. The rear wheels always track the front ones and always follow in the path cut. Combined with 30° rear-axle oscillation, this articulated steering keeps "all four feet" on the ground and also permits a twisting "walk-out" action in poor footing.

Wide-range Drawbar Horsepower. The power train includes a 3-stage, single phase, torque converter, a HOUGH-built full-power-shift transmission, power-transfer differentials in *both* axles and planetary hubs in all wheels. This drive train provides 80% of peak draw-bar horsepower over 75% of the entire speed range so it can push-load efficiently with a wider range of scraper sizes.

Three-way Blade and Push Block. Blade is 160" wide—extending 10" beyond the wheel path on each side, and has special reinforced center area for pushing. Six-way hydraulic control includes raise, lower, tilt to each side, forward and backward pitch. Modified wings help retain the load

while adjustable stabilizer shoes permit precise grade control. A separate pusher block is optional.

Unusual Stability and Smooth Riding are features the operator will notice and appreciate. These are achieved by the approved use of dry ballast material (100% heavier by volume than liquid) in all four tires. It lowers the center of gravity and also reduces the bouncing action usually found in unsprung machines. Standard tires are 33.5 x 33-26 PR, with options including 37.5 x 33. The 4-wheel brakes are air- controlled with dual pedals for operator convenience.

High Availability. One example of the many extra features in this unit to keep it profitably at work and reduce downtime is the separate fan-cooled oil-to-air cooler to effectively control transmission-converter oil temperatures. Full-shift fuel capacity is provided. An optional central lubrication system can be furnished that automatically lubricates 27 different points every 30 minutes of operation.

Your HOUGH Distributor is ready to show you why there is nothing like the D-500 PAYDOZER.

THE FRANK G. HOUGH CO. 12-B-1
726 Sunnyside Avenue, Libertyville, Ill.

Please furnish complete data on the D-500 PAYDOZER

Name _____

Title _____

Company _____

Street _____

City _____ State _____

THE FRANK G. HOUGH CO.
LIBERTYVILLE, ILLINOIS
SUBSIDIARY · INTERNATIONAL HARVESTER COMPANY

HOUGH, PAYLOADER, PAYDOZER, PAYMOVER, PAYLOGGER, PAYLOMATIC and PAY are registered trademark names of The Frank G. Hough Co.

HOUGH®

PAYDOZER®

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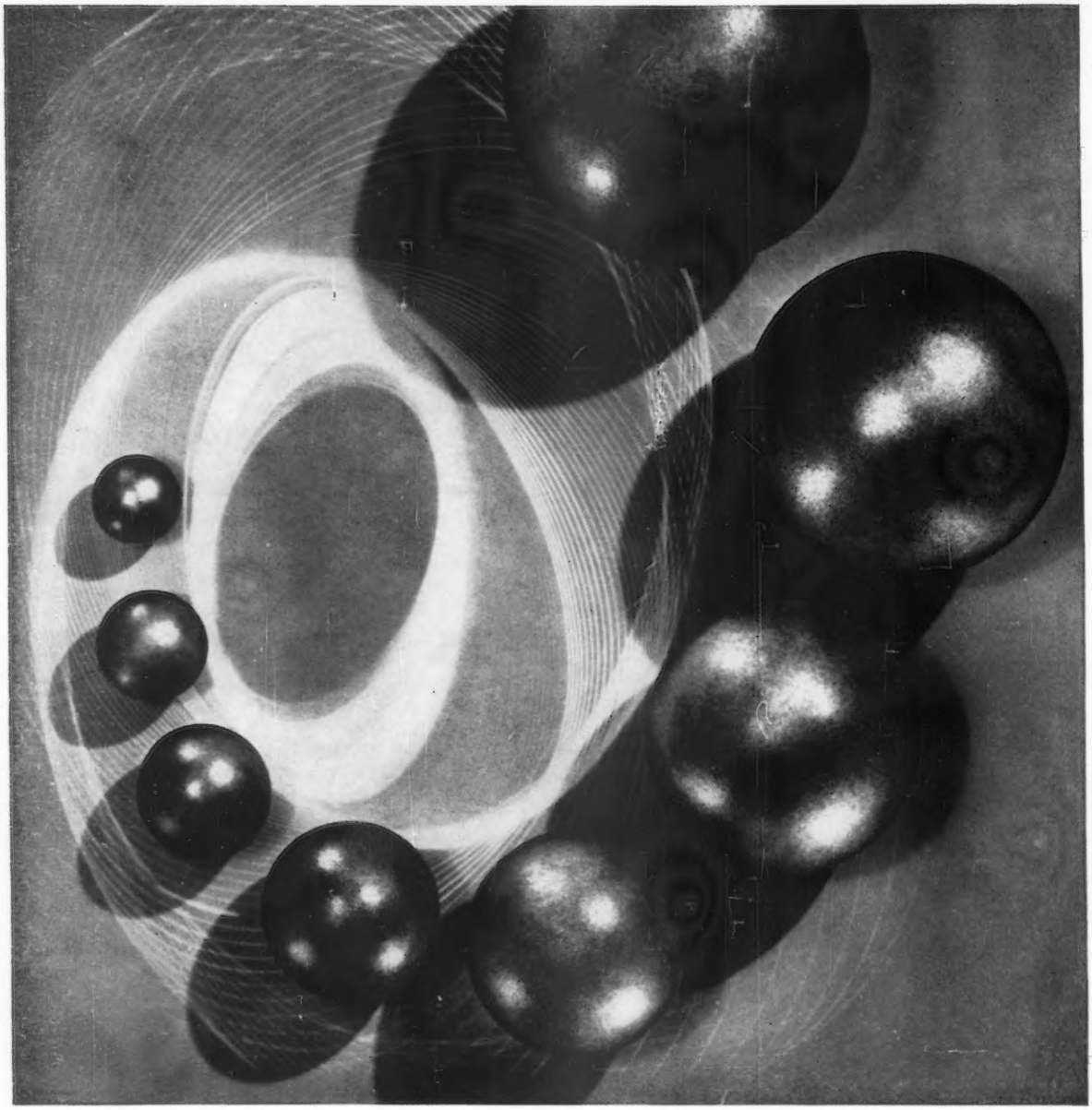

CF&I controls grinding ball quality all the way

As an integrated manufacturer, CF&I has an opportunity to exercise careful quality control at every stage of grinding ball manufacture, from the mine to the finished product.

The result is forged alloy and carbon steel balls that have outstanding hardness (resistance to wear), toughness (resistance to impact splitting), uniformity of roundness and uniform density. These uniform physical properties mean better milling results for you—the user.

CF&I Grinding Balls are available in the following range of sizes: Forged Alloy Steel Balls—1½″ to 4″ in diameter; Forged Carbon Steel Balls—¾″ to 5″ in diameter.

Other quality CF&I Steel Products for The Mining Industry
Grinding Rods • Mine Rails and Accessories • Rock Bolts • Realock
Metallic Fabric • Industrial Screens • Wickwire Rope • Grader Blades

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TODAY'S PATENTS

Tomorrow's technology

OLIVER S. NORTH

U. S. PATENTS

Metal & Mineral Processing

To extract metal values from aqueous solutions of complex metallic cyanides, such as cyanide solutions from which gold has already been recovered, the solution is brought to a pH above 7 and contacted with a nitrogenous anion exchange resin. Metals such as nickel, cobalt, silver, lead, osmium, iridium, palladium and selenium are preferentially absorbed, while copper and iron ions are passed on through the bed. J. Aveston, D. A. Everest and R. A. Wells, assigned to National Research Development Corp. U.S. 3,001,868.

To dry beneficiate sylvinite ores containing langbeinite, ore ground to the point at which the minerals are liberated is air tabled to separately recover sylvite and langbeinite fractions, and these fractions can then be sized to recover coarse and fine products. J. H. Sholine and C. C. Cook, assigned to International Minerals & Chemical Corp. U.S. 3,002,616.

E&MJ Monitor

In the 3-stage sintering of iron ore-fuel mixtures on a sinter grate or band, improved heat efficiency is obtained by drawing a hot gas through the bed to ignite the contained fuel and form a melting zone, limiting the width of the melting zone by drawing a cold gas through, and then again passing hot gas through the bed. K. Meyer and H. Rausch, assigned to Metallgesellschaft A.G. U. S. 3,003,863.

Lake Superior hematite or other sticky iron oxide ores are beneficiated by mixing the wet ore with a sufficient proportion of previously sintered dry material to reduce the over-all moisture content to 3-7.5%, and the mixture screened at 3/16". The screen throughs are then remoistened to the desired water content for mixing with fuel and other materials to form pellets for sintering, while the screen oversize is suitable for direct use in blast furnaces. H. M. Kraner and R. A. Limons, assigned to Bethlehem Steel Co. U. S. 3,003,864.

To recover columbium from pyrochlore, koppite, niocalite, or columbite-tantalite type ores, the ore is treated with dilute H_2SO_4 of a concentration between 35 and 75%, whereby columbium mineralization is decomposed. The values are then extracted by known methods, using organic leaching agents. Acid consumption is lower than when roasted ore is digested in concentrated acid. B. J. Lerner, assigned to Gulf Research & Development Co. U. S. 3,003,867.

To leach manganese-bearing slags to obtain an enriched feed material for the electrolytic production of manganese, an aqueous acid solution is fed to the slag at a rate whereby the pH of the leaching slurry is maintained at a value of at least 3.5, and the final slurry treated with ammona to a pH of about 6.5. This slurry is readily filterable. M. C. Carosella, assigned to Union Carbide Corp. U. S. 3,003,936.

Copies of U.S. patents can be purchased at 25c each from Commissioner of Patents, Washington 25, D.C.

CANADIAN PATENTS

Metal & Mineral Processing

To protect mineral fines such as coal, mineral concentrates, flotation or cyanidation tailings, and the like from wind and rain erosion when stored in the open, the piles of material are coated with an aqueous emulsion of an alkyd resin. R. E. Layman, Jr., R. B. Booth and L. P. Moore, assigned to American Cyanamid Co. Sept. 19, 1961. Canadian 627,634.

In the separate recovery of cobalt and nickel from lateritic ores, the ground ore is leached with sulphur dioxide to selectively extract the cobalt, and the residue is treated by conventional means to recover the nickel. A. Illis, assigned to International Nickel Co. of Canada Ltd. Sept. 19, 1961. Canadian 627,819.

In an installation for classifying asbestos fiber, the fiber is projected into a spiral air stream, and the air stream is intercepted at spaced intervals by a contrary force. Fibers of lighter weight are drawn inwardly out of the spiral air stream. L. P. Bonneau, assigned to Quebec Dept. of Mines. Sept. 26, 1961. Canadian 628,028.

To recover ionizable metals from ore leach solutions, the solution is contacted with a chelate exchange resin having a large capacity for chelate-binding metal ions. This method is suitable for separation of copper, silver, gold, cobalt, nickel, zinc, platinum, and other metals. R. A. Mock, R. C. Calkins and C. A. Marshall, assigned to Dow Chemical Co. Sept. 26, 1961. Canadian 628,070

Improved apparatus and process for the continuous digestion of bauxite ore in the form of a slurry in caustic liquor. Gas and slurry are removed alternately through the same discharge line. Accumulation of scale on the inner walls of the digester is prevented, and gas build-up is minimized. A. C. Kelly, assigned to Aluminium Laboratories Ltd. Oct. 10, 1961. Canadian 628,999.

Copies of Canadian patents can be obtained by writing to Commissioner of Patents, Patent & Copyright Office, No. 8 Bldg., Carling Ave., Ottawa.

BRITISH PATENTS

Metal & Mineral Processing

In the froth flotation concentration of columbium-bearing minerals from alkaline ores containing columbium values, the amine-conditioned pulp is treated with a water-soluble bicarbonate of ammonia, potassium or sodium to improve recovery and lessen the amount of gangue material floated. H. L. Noblitt. Sept. 6, 1961. British 876,657.

To reduce iron oxide ores, pulverized ore is fed through a series of cyclones in which it is blown with hot reducing gases produced from a carbonaceous material. The quality and temperature of the reducing gases are regulated so as to prevent caking of the material in the cyclones. Y. Nogiwa. Sept. 6, 1961. British 876,765.

Method of reducing zircon-ilmenite ore mixtures with carbon to produce a ferro-alloy melt and a zirconium-titanium slag which can be chlorinated and crushed for use as a high quality abrasive. Assigned to National Lead Co. Sept. 6, 1961. British 876,778.

In the preparation of a water-swelling bentonite from normally non-swelling or only slightly-swelling alkaline earth bentonite, the clay is treated with $MgCO_3$ in the presence of or followed by the addition of Na_2CO_3. The activated material is then dried and ground. Assigned to Sud-Chemie A.G. Sept. 13, 1961. British 877,074.

To produce iron ore briquettes not requiring a binder yet having a dequate strength, 40-65% of ore concentrates or other fines are admixed with 25-45% of hard coal or brown coal and 5-15% of a hydrate of lime or magnesium, and the briquettes pressed at a pressure above about 1000 kg./sq. cm. W. Petersen and S. Wawroschek. Sept. 20, 1961. British 877,932.

In the alkali digestion of siliceous bauxite wherein a large part of the NaOH is recovered from the red muds, the mud is washed and treated in an aqueous medium with a quantity of finely divided lime or other alkaline earth metal oxide which is proportioned to the silica content of the mud. The resulting suspension is readily filterable, and the NaOH liquor obtained is suitable for use directly in the Bayer process. Assigned to Pechiney, Compagnie de Produits Chimiques et Electrometallurgiques. Sept. 27, 1961. British 878,082.

NEW BOOKS

Keeping up with your profession

Froth Flotation, 50th Anniversary Volume, edited by D. W. Fuerstenau. This technical volume, which is being published as part of the commemoration of the 50th Anniversary of Froth Flotation in the U.S., is sponsored by the Minerals Beneficiation Division of AIME, and is being financed by the Rocky Mountain Fund. Only a limited number of copies will be printed.

The volume will contain twenty-three specially authored chapters on subjects which should be of interest to all flotation engineers and students. Topics which are included in the volume encompass certain historical aspects of the development of flotation, but the main emphasis has been on the magnitude of the present-day flotation industry, scientific and engineering flotation fundamentals, current plant practice, flotation economics, and the outlook for flotation.

Representative chapters include: "Flotation Economics," by Stanley Michaelson and Norman Weiss; "The Magnitude and Significance of Flotation in the Mineral Industries of the United States," by Charles W. Merrill; "Plant Practice in Sulfide Mineral Flotation," by Frank McQuiston and Elmer Tveter; "Flotation Kinetics," by Nathaniel Arbiter and Colin Harris; "Automatic Controls for Flotation Plants," by C. G. H. Bushell, W. Barbarowicz and J. E. Lawver; "Theory of Sulfide Mineral Flotation," by John Rogers; and "Froths and Frothing Agents," by R. B. Booth and W. L. Freyberger. See also the feature section in this issue.

Available through the AIME, 345 E. 47 St., New York 17, N.Y. Price $10 for AIME members, $14 for non-members.

Petroleum Exploration Handbook, A Practical Manual Summarizing the Application of Earth Sciences to Petroleum Exploration, edited by Graham B. Moody. One of the five volumes in McGraw-Hill's Petroleum Handbook Series, this book combines field geology, subsurface geology, geophysics and reservoir mechanics.

The book includes sections on exploration philosophy, personnel organization, origin, collection and entrapment of oil, active field examinations, interpretation of results and the report, exploratory drilling and estimating reserves. There is also ample material on laboratory procedures and on exploration research and scouting. Published by the McGraw-Hill Book Co., 330 W. 42 St., New York 36, N.Y. 831 pp, 328 illus. Price $23.50.

Geology of the Mandera-Damassa Area, Report No. 48, by P. Joubert. Printed by the Government Printer, Nairobi, Kenya. 65 pp plus maps. Price Sh. 22/50.

Report of the Mines Department 1960, This booklet includes a short description of work done on recently discovered bauxite deposits. Available from the Government Bookshop, Water Street, Freetown, Sierra Leone. 27 pp. Price 3s. 6d.

Standard Refrigeration and Air Conditioning Questions and Answers, by Stephen M. Elonka and Quaid W. Minich. This book contains chapters on refrigeration systems, refrigerants, compressors, condensers, evaporators, refrigerant controls, electric controls, piping and fittings, lubrication and seals, defrosting, compressor and motor drives, calculations and definitions, operation servicing, and trouble-shooting. There is also material on cooling towers, cooling water and brines, safety and cryogenics. Published by the McGraw-Hill Book Co. Inc., 330 W. 42 St., New York 36, N.Y. 235 pp. Price $6.95.

E&MJ Monitor

Russian Translating Programme. The English National Lending Library for Science and Technology is currently translating various Russian technical journals and books into English. They also translate articles on request with certain provisions, and lend books from their large Russian library. Activities of the NLL are published monthly in the NNL TRANSLATION BULLETIN available from H.M.S.O., P.O.B. 569, London, S.E.1, England. Annual subscription for the bulletin is £2.13s 0d., single copies 4s. 0d.

Experimental Methods in Combustion Research, edited by J. Surugue. This manual is designed primarily for researchers working on combustion engines, but should be useful to anyone working with combustion. Published for and on behalf of Advisory Group for Aeronautical Research and Development, North Atlantic Treaty Organization, Available, in easily supplemented, loose-leaf book form from Pergamon Press Inc., 122 E. 55 St., New York 22, N.Y. Price $15.00.

Books presented on this page may be obtained directly from the publisher mentioned in each case. E&MJ does not sell books.

Geological Map of New Zealand, Sheet N94, Taupo. Scale 1:63,360. Published by the Dept. of Scientific and Industrial Research, Wellington, New Zealand.

For the Years to Come, A Story of International Nickel of Canada, by John F. Thompson and Norman Beasley. This is an historical work, dealing mainly with the people responsible for the discovery and development of the world's largest nickel producer. The authors have also captured some of the flavor of the changing times and political maneuvering during the past half century. Published by G. P. Putnam's Sons, 210 Madison Ave., New York 16, N.Y. 374 pp. Price $5.00.

The following publications are for sale by Superintendent of Documents, Government Printing Office, Washington 25, D.C.

Mining and Milling Methods and Costs, Madison Mine, National Lead Co., St. Louis Smelting and Refining Division, Madison County, Mo., USBM IC 8028, by H. D. Kline, W. A. Calhoun and B. M. Reynolds. This circular contains a fairly complete breakdown of costs for 1956. 26 pp.

Manganese Deposits in the Drum Mountains Juab and Millard Counties, Utah, USGS Bulletin 1082-H, by Max D. Crittenden, Jr., Hohn A. Straczek and Ralph J. Roberts. 51 pp plus maps.

Petrography of Radioactive Tertiary Igneous Rocks, Front Range Mineral Belt, Colorado, USGS Bulletin 1032-E, by John D. Wells. Book includes geology and ore deposits of Clear Creek, Gilpin and Larimer Counties, Colo. 49 pp plus maps.

Geologic Reconnaissance of Kiska Island, Aleutian Islands, Alaska, USGS Bulletin 1028-R, by Robert R. Coats, Willis H. Nelson, Richard Q. Lewis and Howard A. Powers. 18 pp.

Paleozoic and Cenozoic Rocks in the Alpine-Nutrioso Area, Apache County, Arizona, USGS Bulletin 1121-H, by Chester T. Wrucke. 26 pp. Price 15¢.

Reports and Maps of the Geological Survey Released Only in the Open Files, 1960, USGS Circular 448, by Betsy A. Weld, Erwin S. Asselstine and Arthur Johnson. 15 pp.

Drill-Dust Collectors and Drilling Equipment with Integral Dust-Collecting Systems Approved by the Bureau of Mines as of January 31, 1961, USBM IC 8027, by Floyd G. Anderson and R. L. Evans. Approval is for coal mining. 28 pp.

Geology of the Cross Plains Quadrangle, Callahan, Coleman, and Eastland Counties, Texas, USGS Bulletin 1096-B, by Philip T. Stafford. 72 pp plus maps.

Index of Metallic and Nonmetallic Mineral Deposits of Alaska Compiled From Published Reports of Federal and State Agencies Through 1959, USGS Bulletin 1139, by Edward H. Cobb and Reuben Kachadoorian. 363 pp plus map.

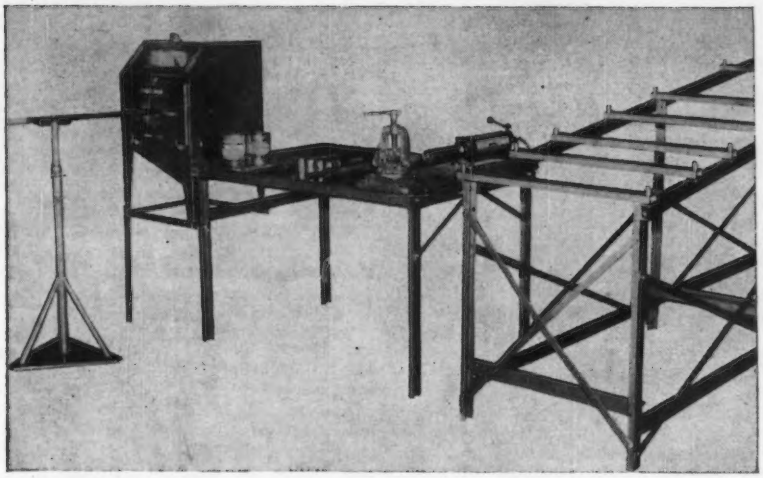
Geology of the Bonner Quadrangle, Montana, USGS Bulletin 1111-F, by Willis H. Nelson and Joseph P. Dobell. 46 pp plus map.

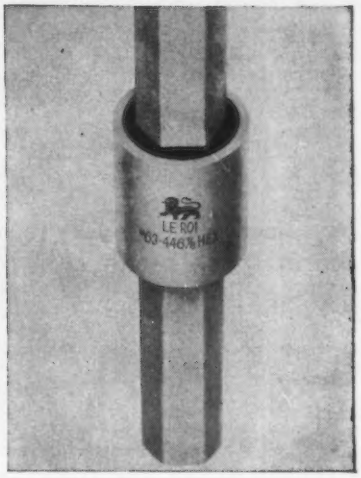
The Uranium-Vanadium Ore Deposit at the Monument No. 1-Mitten No. 2 Mine, Monument Valley, Navajo County, Arizona, USGS Bulletin 1107-C, by Irving J. Witkind. 23 pp.

Geology of Central Dickinson County, Michigan, USGS Professional Paper 310, by H. L. James, L. D. Clark, C. A. Lamey and F. J. Pettijohn. 176 pp plus maps.

NEW EQUIPMENT

Tomorrow's tools and methods





Rubber-Lined Drill Steel Collar Absorbs Shock and Reduces Breakage (11)

ONE OF THE MOST SIGNIFICANT new products for drilling operations is the rubber-sleeved drill steel collar developed by Le Roi Div., Westinghouse Air Brake Co. It can be attached to steel measuring from ⅞ in. to 1 in. and will absorb shock and reduce breakage.

Le Roi said the rubber-lined collar reduces the initial cost of making up drill steel by eliminating the use of expensive forging or heat treating equipment. Since the heat treat process has been eliminated, alloy steel can be used for drill steel.

According to Le Roi, the collar is a steel sleeve, 2 in. long and 1½ in. in dia with rubber bonded to the inside diameter of the sleeve by a patented process. The same process bonds the rubber-lined collar to the drill steel. While the collar is being attached, the drill steel is clamped in a vise (left) in line with the air cylinder to position the collar accurately on the steel.

Here are the companys' instructions for assembling the collar:

1. Thoroughly clean the drill steel by sand blasting or using a good solvent and a wire brush.

2. Measure out prescribed amounts of the two Le Roi cements and mix thoroughly with a spatula on a flat surface or in a can or cup.

3. Clean surfaces to be bonded by wiping with clean acetone or other grease-free solvent, and allow to dry.

4. Spread the adhesive to both members. Use any convenient tool (spatula or trowel) and obtain as good coverage as possible.

5. Place drill steel in assembly fixture. Position drill steel striking face as indicated on fixture. Secure drill steel with vise to avoid spillage during assembly.

6. With collar jack fixture fully retracted, place collar in collar holder. Be sure that collar is in alignment with drill steel shank.

7. Actuate air cylinder control lever to press collar onto the drill steel until stop is reached. If properly installed, the collar should be from 4 3/16 to 4¼ in. from the striking end of the drill steel.

Retract the piston rod by actuating the air cylinder control lever. Remove the drill steel from the vise and allow to cure for 24 hr before using. Curing could be accelerated by baking for 4 hr at 200° F.

Added to the labor and forging cost savings, the rubber-lined collar reduces the drill steel inventory needed at the mine. The water flushing hole is no longer distorted by the forging process.

Le Roi said that extensive product testing carried out at large underground operations reveal that thread or taper wear and breakage at the bit end of the steel is lowered—most of the dangerous vibration is absorbed by the collar. Climax Molybdenum Co. reported that 100 ft had been drilled on one 8-ft steel which had a rubber collar. This, Climax reported, was approximately three times the footage that could be obtained on a conventional steel collar.

Ground Elevation Meter (1)

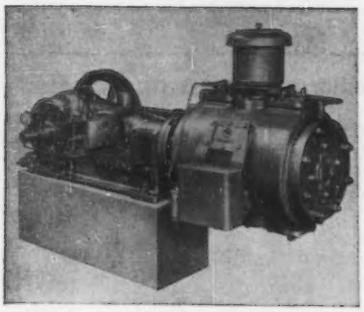
MOBILE GROUND ELEVATION METER, suitable for highway or cross-country use, and which can survey relative ground elevations at speeds up to 40 mph, has been developed by the Sperry-Sun Well Surveying Co.

The electromechanical measuring and recording apparatus is mounted in a four-wheel drive, four-wheel steer GMC Suburban truck with V-6 motor. Relative ground elevations, according to Sperry-Sun, are obtained by measuring the instantaneous angle of inclination and the instantaneous velocity of the meter along the path traversed. These data are fed into a transistorized electronic computer which continuously evaluates the information.

The truck's fifth wheel assembly, combined with a recording pendulum, serves as the velocity generator and also measures the instantaneous inclination angle. The front and rear left tires are used as an index for the inclination instrument. Since any change in relative tire diameter will cause an error in the pendulum angle, the air pressure in these tires is monitored

and accurately maintained through a regulated air pressure system.

Sperry-Sun said their meter may be used in mapping and contour work with an accuracy equivalent to transit stadia or "fly" spirit leveling.

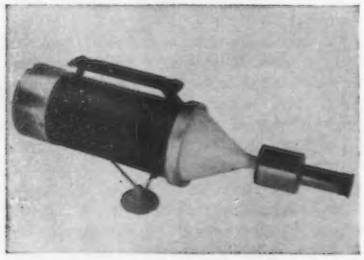


New Compressor Line (15)

NEW LINE of heavy duty compressors for continuous operation in all types of service has been introduced by Gardner-Denver. The five types in the new series are: standard, oil-free, tandem, gas, and vacuum.

G-D said the new units will be in the 20 to 150-hp range with maximum speeds up to 675 rpm and capacities ranging from 108 to 1592 cfm displacement.

The company said the most important new feature of the horizontal, single-stage compressors is a system of positive force feed lubrication. Other features include: one-piece solid luberized cross heads, duo-plate "cushioned" valves, and complete water jacketing of cylinder for low discharge temperatures.



Dust Sampler (17)

A DUST SAMPLER that's designed to simulate the collection characteristics of the human lung, the Unico "Respirable," has just been introduced by the Union Industrial Equipment Corp. The sampler is a complete two-stage collector consisting of a cyclone in series with a high-efficiency filter. The cyclone stage captures the larger particles, those which deposit in the upper respiratory passages. The smaller particles, those which penetrate the lower lung, are captured by the filter.

Union said that since the maximum permissable air concentration values for insoluble eternal emitters used by the AEC are based on the arbitrary assumption that only 12½% of the weight of an aerosol reaches the site of toxic action (non-ciliated portion of the lung), a true respirable dust sample will provide a superior estimate of exposure.

The company then said that the Unico 240 unit (photo) satifies the AEC criteria for respirable dust samplers.

Huge Dump Truck (6)

SINGLE REAR AXLE, end dump truck, the Haulpak 65, said to have the world's largest capacity, was recently introduced by LeTourneau-Westinghouse. Though the monster is one of the largest end-dump trucks, its extra high yield strength steels keep the weight down to 69,850 lb empty—only 54% of its payload of 130,000 lb.

LeTourneau-Westinghouse said that the 65 is one of the most versatile end-dump trucks ever developed. The frame was designed to accommodate either a rock or coal body. The rock body (top) has a 42-cu yd capacity, struck, and will haul a 65-ton payload. The coal body will also haul 65 tons and has a 66 cu yd capacity.

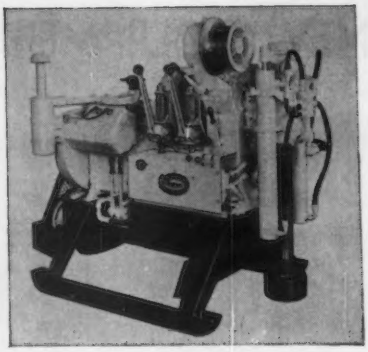
All Haulpak trucks have the entire steering system protected within the frame, giving almost twice the ground clearance of conventional vehicles. They are easy and safe to handle, with full power steering and power brakes. The 160-in. wheelbase makes them extremely maneuverable and the turning circle on the front wheel track is only 55 ft.

Tractor-Trailer Unit (18)

KW-DART TRUCK CO. has developed a new 50- to 60-ton payload tractor-trailer combination which has a great deal of hi-tensile steel in the body and frame.

The unit, the D6330 Series, is available either as a tractor-trailer combination, or as a trailer only, complete with universal-type hitch for installation on standard trucks.

D6330 is powered by a Cummins VT8-430, 430-hp diesel, and is available with a four speed transmission and converter.



Versatile Diamond Drill (7)

THE FIRST DIAMOND DRILL with built-in wire line hoist, the "38," was introduced last summer by E. J. Longyear Co. It has an eight-speed transmission with spindle speeds from 69 to 1850 rpm with engine running at 2200 rpm. Special low-range speeds, according to the company, permit efficient casing rotation, rock bitting, soil sampling and other appliances calling for low rotation speeds.

The "38" may be operated with ease —the unit's "Control Center" design places the levers at the operator's fingertips. Gasoline, diesel, air or electric power units are optional.

Capacity of the "38" is 2800 ft with AW rods or 1750 ft with NW rods.

E&MJ Monitor

New Chevrolet Diesels (16)

FOR THE FIRST TIME, Chevrolet is producing diesel-powered medium and heavy-duty trucks. The company said a GM "4-53" diesel will be available for 15 conventional cab models resting on five wheelbases from 133 to 197 in. with GVW range from 15,000 to 23,000 lb. The engine is a four-cylinder, two-cycle model capable of 130 hp and 271 ft/lb of torque.

Two new gasoline V-8s—one developing 185 hp and the other developing 252 hp—are offered as optional power units. For off-highway operations, two new extra-heavy duty I-beam front suspensions with leaf springs are available options for most models in the heavy-duty series.

Curved Rock Buckets (3)

NEW CURVE NOSE ROCK BUCKET, which has no teeth and which can easily and quickly penetrate a blasted rock pile, has been developed by the Trojan Div., Yale & Towne Mfg. Co.

The center of the bucket cutting edge protrudes 8 in. beyond the edge at the bucket corners. Trojan said that on contact with the pile, the entire power of the tractor shovel is confined to only 30% of the cutting edge surface, rather than across the entire bucket edge as with standard buckets.

Hardened steel scuff plates are welded on the inside of the curve nose rock bucket to serve as extra wearing surface and as friction reduction agents during loading and dumping.

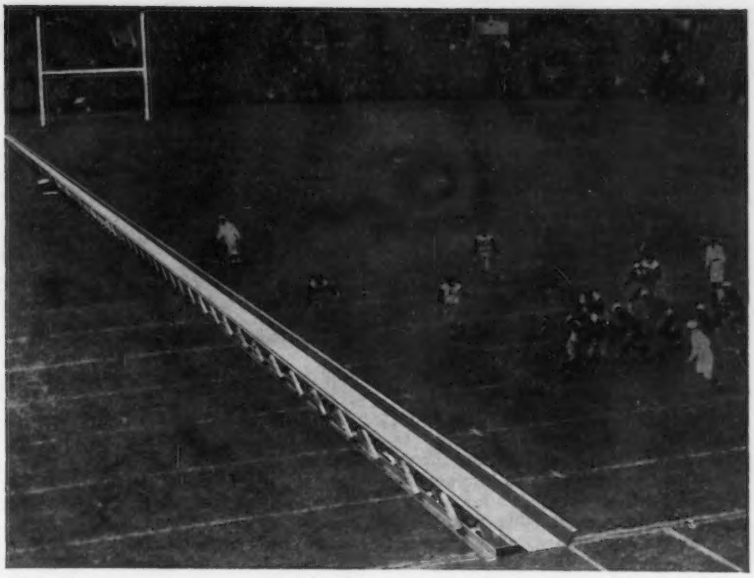
Trojan's new buckets are made of low-alloy, high-strength steels to give them longer service life.

Single Wedge Gate Valve (5)

NEW LINE of 150-lb gate valves featuring a single wedge for handling corrosive liquids with solids in suspension and corrosive viscous fluids has been announced by Alloy Steel Products Co.

The valves are available with four different end designs: flat-face flanged ends in sizes from 1/4 in. through 18 in., standard ASA raised face flanged ends in sizes from 1/4 in. through 18 in., screwed ends in sizes from 1/4 in. through 2 in., and butt welding ends.

In addition to the variety of end designs, the gate valves are available in any of a number of different corrosion-resistant alloys.



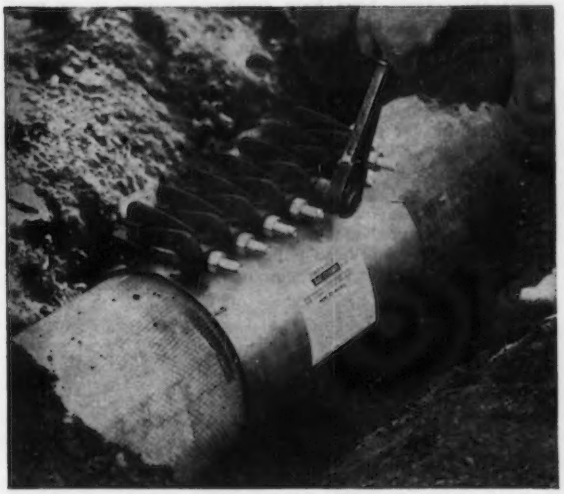
Stephens-Adamson Installs Huge Vibrating Conveyor (4)

A NATURAL FREQUENCY vibrating conveyor—measuring almost 300 ft and believed to be the longest in the world—was built recently by Stephens-Adamson Mfg. Co. It has a 6 tph capacity and a 36 tph surge capacity.

Most of the energy needed to operate the unit comes from the natural frequency (resonance) of the coil springs. As the springs vibrate the trough, power is generated in the compression and extension strokes and then used to help start the next stroke. Therefore, only a small amount of additional energy is needed to maintain the vibration stroke.

Elmer Renner, Stephens-Adamson vice president, said "one of the advantages offered by natural frequency vibrating conveyors is that they require only a small amount of headroom. Material can be moved up inclines to 10°, so only a minimum amount of space is needed where one conveyor fits into another."

Stephens-Adamson's conveyor will be used by a glass firm to collect scrap from cutting machines.



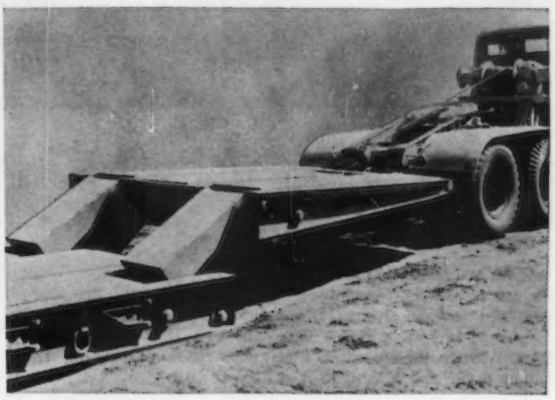
Improved Pipe Clamp (14)

DRESSER MFG. DIV., Dresser Industries, Inc. has introduced a wrap-around pipe repair clamp which has bolts on one side and a thick, butt-seal gasket. Called "Dresser 360 All-Around Clamp," the new device allows a ⅜-in. adjustment on diameter so that a single clamp will fit a large number of pipe diameters.

The clamp is designed for repairing holes, circumferential breaks or splits, and can be used on both the rough barrel or machined ends of asbestos-cement pipe, and on the run of cast-iron and steel pipe. Dresser said it may be used where pipe ends are deflected up to 4° or offset ⅛ in.

The company also stressed that the 360 clamp can be applied by even an unskilled workman—the unitized design makes it easy to wrap around and slide into position.

Style 360 is available in normal sizes from 2 to 12 in., fitting pipes with outside diameters from 2.38 to 14.50 in.



Light Gooseneck Linkage (51)

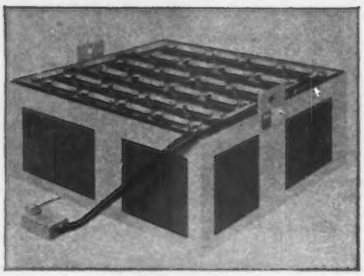
WEIGHT OF THE MARTIN Folding Gooseneck trailers, the Tractor Equipment Div., Hyster Co. recently announced, has been reduced 200-300 lb by making the gooseneck linkage of lightweight "T-1" steel. This is now a standard feature of all Martin Folding Gooseneck trailers of 15 through 35 tons.

Exide Increases Electrical Capacities of Nickel-Iron Batteries by 77% (10)

AN IMPROVED NICKEL-IRON alkaline storage battery—having an electrical capacity boost of 77%—has been developed by the Electric Storage Battery Co. For the first time, the company announced, the units can match the capacity of some of the most powerful batteries designed for electric industrial trucks in heaviest-duty, longest-shift material handling operations.

Called the E line, they are capable of producing 100 ampere-hours per positive plate, and now produce 1.202 watt-hours per cu in., up from 0.68 watt-hours in the former design. Exide added that the E line is available in five standard electrical sizes—400-, 500-, 600-, 700- and 800-AH capacities—adequate for trucks rated up to 8000-lb lifting capacities. The company plans to increase the line to include larger models for heavier trucks and to convert other nickel-iron lines to the new design, all with comparable capacity increases.

Exide has boosted capacity by increasing the percentage of power-producing materials per cube of battery. The perforated nickel-steel tubes that contain the positive active material now run from the top to the bottom of the plate. They are reinforced by seamless steel rings around them. Previously, rows of parallel tubes, fastened end-to-end



on a grid, were used to span the length of the plate.

Similarly, the company reported, perforated steel strips that contain the negative active material now run the entire length of the negative plate. The negative active material had been contained in rows of short rectangular pockets pressed onto a grid framework. The plates are now almost solid masses of active materials.

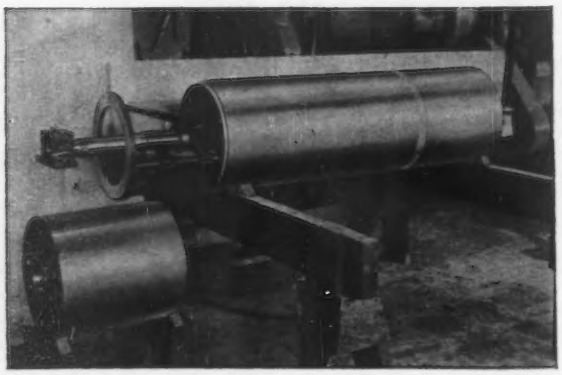
Positive tubes are held in place by all-welded construction to bars at top and bottom. The negative strips are crimped together, fastened at both top and bottom, and corrugated laterally across the face for extra structural rigidity. A rack at the cell bottom supports the plates, and round plastic pins between the plates and steel connecting rods with steel spacing washers between the tops of the plates provide proper insulation and separation.

Nickel-iron battery interconnected cells had been assembled in wooden trays. These have been eliminated—cells are now assembled in space-saving steel cradles in sizes to fit standard truck compartments.

Cell terminals are now straight instead of tapered. They not only provide better electrical conductivity, Exide said, but also make it easier to remove connectors.

Exide's improvements have allowed the Type E to have even longer service life than is traditional with this type of battery. All the important parts—containers, pole pieces, connecting rods, tubes, strips—are made of steel. The active material, freely accessible to the electrolyte through the tube and strip pocket perforations, cannot be dislodged. Therefore, Exide reported, there is a minimum loss of electrical capacity during the life of the cell, and sediment does not accumulate at the bottom of the cell.

Positive action material is alternated with layers of nickel flake within the tubes to give better electrical conductivity.



Roll-Magnet Unit (2)

FOR THE FIRST TIME, according to a recent announcement from Barclay Machine, Inc., a Type IV Lorig-Aligner Roll and permanent magnet have been combined into a single head pulley. The 82-in. unit (photo) assures accurate, continuous alignment and tracking of the 80-in. wide belt in spite of frequent off-center positioning of heavy surge loadings.

The permanent magnet is mounted on a frame inside the roll, and does not rotate with it. It has a 150° arc, and its position inside the roll can be changed to vary the amount of pull on the material for removing tramp iron and other foreign objects, also to vary the trajectory and location of the storage pile when the belt is handling pelletized ores and other magnetic materials.

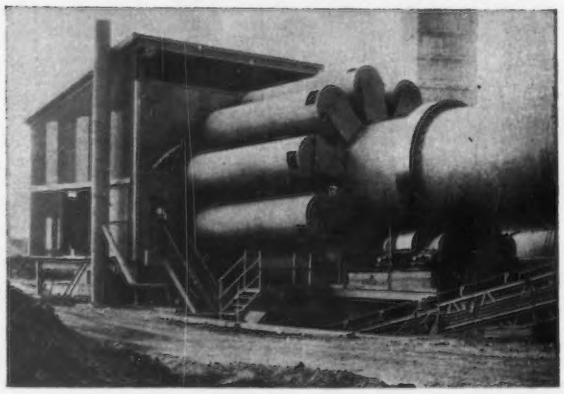
Barclay announced that it is prepared to supply the positive belt aligning magnetic head pulleys in a wide range of widths and diameters to meet any requirement.

Integral Tube Coolers (13)

ALLIS-CHALMERS announced that the first integral tube coolers in the light-weight aggregate field were recently installed at Material Service, Ottawa, Ill., a division of General Dynamics.

The 11-ft 3-in. x 200-ft A-C kiln with 10 4½-ft-dia x 20-ft long Warner tube coolers was made from an existing 120-ft rotary dryer and a new 80-ft section furnished by A-C.

The tube coolers, Allis-Chalmers said, are integral with the kiln and require no additional supporting piers. This type of cooler increases efficiency and conserves space in the shale-producing facilities. With the addition of the third kiln, Material Service's capacity has been increased by 50%—making it the largest producer of lightweight aggregate in the country.



OPERATING BULLETINS

Free aids to better planning

HOW TO SELECT and use core barrels in diamond drilling are topics discussed in an informative illustrated booklet from the E. J. Longyear Co.

The following barrels are described and shown in cross-section: single tube, double tube rigid, Canadian double tube rigid, and large series, double tube swivel. Three types, the "L" series double tube, swivel type and the series "10" wire line core barrel and the series 100 core barrels for air, mud or water, are described in greater detail.

Longyear rounds out its presentation with a brief history of the development of core barrels. **(74)**

HOW GRINDING-BALL WEAR may be studied by a radioactive tracer technique is covered in a comprehensive six-page reprint from Coates Steel Products Co.

According to Coates, the test objective was to determine the relative effects of certain chemical and physical properties on the wear resistance of grinding balls when grinding cement. In making the study, the company continued, a number of types of balls were used in both dry and wet grinding in commercial mills. The radioactive tracer technique was used in separating the test balls from the rest of the mill charge and in sorting the different types of balls that were all tested at the same time for each of the grinding operations. **(75)**

"HOW CONTRACT RESEARCH Serves the Needs and Objectives of Industry," an illustrated statement that answers questions that often arise when industrial management considers an "outside" approach to its research needs, has just been published by Battelle Memorial Institute.

Battelle points out that contract research is growing at a faster rate than total industrial research in the U.S. and cites reasons for this growth trend. The statement suggests that, as research has become increasingly important in industrial operations, management has become more aware of the ways in which research institutes can complement a company's internal research effort. **(76)**

GASOLINE EARTH BORING UNIT for drilling 2¾- to 12-in. holes, the Ka-Mo G-16, is presented in a new four-page bulletin published by the Kwik-Mix Co.

According to the bulletin, the G-16's advantages are: compact for tight-quarter work; fast and easy set-up; self-contained to eliminate auxiliary power source; and choice of manual or power forward speed. **(77)**

HOW TO Install an Eye Protection Program, published by the Fendall Co., manufacturers of safety equipment, is intended as a guide to the essentials for producing a sound working program and "as an aid in developing thoughts which pertain most directly to your own company and its problems."

Fendall said that most companies feel the need for, and have genuine intentions of, instituting a sound eye protection program. However, the program is often delayed because answers to questions concerning cost, scope and enforcement of such programs are not readily available. In plants and mines without an established safety department, there may be a hesitancy to delegate the responsibility for such program without giving the responsible person substantial material with which to work. Fendall's clearly-written booklet supplies that type of substantial material. **(78)**

OPERATION and application of air cylinders are described in a new manual published by Rivett Lathe & Grinder, Inc. **(79)**

ILLUSTRATED, eight-page, two-color bulletin from Keller Glove Mfg. Co. gives data on the selection of KELNIT gloves for industrial hand protection and describes 69 different types of gloves, hand pads, mitts and sleeves made of an exclusive KELNIT pile fabric. **(80)**

NEW 18-PAGE booklet which supplements a comprehensive machinability study with data on the properties and performance of Amsulf, a high-conductivity copper-sulphur alloy produced by American Metal Climax, Inc., has been published by the company's Amco Sales Div.

The machinability report, comprising a major portion of the new booklet, summarizes the results obtained in a study conducted by the Technical Development Steering Committee of National Screw Machine Products Association. **(81)**

CHART showing the resistance of all generic fibers to acids, alkalies, salts, solvents and oxidizing agents, has been prepared by the Filtration Fabrics Division of American Machine & Metals, Inc. It indicates the concentration and temperature of the reagent and the extent to which the fiber and/or reagent resist chemical change. The chart also defines the generic, man-made fibers and specifies the various trade names. **(82)**

FOOTE MINERAL CO. has published a new edition of its products catalog. It lists lithium chemicals, metal and minerals, electrolytic manganese, zirconium, welding grade products, and steel addition agents for applications in the chemical, metallurgical and mining industries. **(83)**

THE D-8-H Heavy Duty Track Shoe is described in a four-page, two-color bulletin (1078) recently published by Columbia Steel Casting Co.

The bulletin gives drawing numbers, weight, dimensions and metallurgical information, including a discussion of the advantages of duplex furnace technique in the manufacture of replacement parts for tractors and shovels. **(84)**

OPERATING CHARACTERISTICS of vane pumps at pressures up to 2500 psi are presented in a four-page bulletin (200-A) from the Denison Engineering Div., American Brake Shoe Co.

The new publication discusses the company's series TIC vane pumps and a variety of possible applications in hydraulic circuits. Included are fully documented performance and efficiency charts and schematic diagrams. **(85)**

MACHINES EQUIPPED with short, high-speed belts that hurl free-flowing bulk materials into areas inaccessible to other mechanical means are out-

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OPERATING BULLETINS (Continued)

lined in a new six-page folder (2921) published by the Link-Belt Co.

The company calls them Jetslingers, and the four models described and illustrated are: wheel mounted, suspended swivel mounted, wheel mounted for low headroom, and bracket suspended swivel mounted. **(86)**

COMPLETE LINE of permanent magnetic drum separators used for automatic separation of iron contaminants from bulk materials is being offered by Eriez Mfg. Co. in a new six-page brochure (bulletin B-54-1B).

The bulletin contains specific information on separators from 12- to 36-in. diameters and widths from 8 to 60 in. Principles of magnetic drum operation and how to select correct separating units are also included. **(87)**

BASIC WELDING symbol chart, useful for anyone interested in design, development or manufacturing where welding is used, has been prepared by Lenco, Inc. **(88)**

CAPACITIES, dimensions and power requirements of Anthony-Design, Falls continuous mixers are charted for 14 standard sizes in double or single shaft models in a new catalog (150) from Falls Industries, Inc.

The catalog discusses design details, including the exclusive variable pitch blades to allow changing retention time in the field for applications where flow requirements are uncertain, or where material is friable. **(89)**

EIMCO 126 front end loader, rated at 225 hp and claimed to be the most powerful front end loader now being made, is described and illustrated in a four-page bulletin (L-1174) from the Eimco Corp. **(90)**

COMPLETE LINE of electrohydraulic servo controlled pumps and system components are introduced in a 20-page bulletin (47740) from the Oilgear Co. How the pumps and components work, what functions they perform and where they are applied are described in detail. **(91)**

NEW TWO-PAGE specification sheet presenting specifications, dimensions, weights and product features of the Binder System horizontal vibratory screen has been prepared by COMCO Corp. **(92)**

RESULTS of an abrasion test for refractory brick and monoliths are presented in an eight-page reprint from the Garber Research Center, Harbison-Walker Refractories Co.

The test used impingement of a stream of air-entrained silicon carbide grit to determine the resistance of specimens. Details concerning techniques, equipment and results are described with text, photos, tabulations and charts. **(93)**

THREE BOX-TYPE furnaces with different work-chamber capacities are described and illustrated in a bulletin (1086) published by Lindberg Engineering Co.

Lindberg said that all three furnaces feature economical operation, long element life, plus precision temperature control, and are adaptable to a wide variety of applications in chemical and metallurgical fields such as heat treating small parts, ash determinations, fusions, ignitions, assaying and drying precipiates. **(94)**

SELECTION DATA on 142 standard and special-design miniature and instrument bearings developed by the Barden Corp. appear on a two-page engineering data sheet recently published by the company.

The bearings, ranging in size from .1562 in. to 1 in. O.D., are used in precision instruments, gyros, computers, recording devices and other low torque, high temperature applications. **(95)**

WORN RIMS on crawler tractor sprockets and idlers can be made better than original equipment with Amsco replaceable sprocket and idler rims. According to the company, and described in a new bulletin, the rims are made of austenitic manganese steel and will outwear original equipment rims where impact and abrasion are problems. When worn, they can be economically built up and hard-faced several times for additional life. **(97)**

NEW, REVISED liner plate catalog has been issued by Armco Drainage & Metal Products, Inc. Various applications such as underpasses, service tunnels and freight tunnels, are described, and other sections are devoted to lining old structures, to mine entry shafts, aggregate conveyor tunnels and storage bins. **(96)**

LINE OF ROTARY positive displacement blowers (Type RAS) and gas pumps (Type RGS) is presented in a new bulletin (RAS-261) from Roots-Connersville Blower Div. of Dresser Industries, Inc.

The brochure outlines the advantages of the heavy-duty machines, including positive volume displacement, inherent operating flexibilty that saves hp, high volumetric efficiency, low mechanical friction, adaptability for many gases, compactness, ability to deliver oil-free air or gas, and to handle moderate amounts of entrained liquids. **(98)**

E&MJ Monitor

GUIDE TO THE SELECTION OF DIAMOND BITS and reaming shells, an illustrated eight-page handbook of great value to operators of diamond drilling equipment, has been published by E. J. Longyear Co.

Part of the presentation is Longyear's diamond bit selector-chart which is divided into coring bits, casing shoes and bits, non-coring bits, and reaming bits and tapered reamers. For each type, the company gives the size and design numbers and the bit numbers that apply to the varying conditions under which they will be put to use. **(99)**

ERIEZ MFG. CO. has published two bulletins to describe their permanent magnetic drum separators and pulleys.

The drum separators brochure (B-54-1B) outlines the company's new line of five models.

The permanent magnetic pullleys brochure (B-50-1A) describes what the company calls "the most complete line ever." The pulleys come in two designs, four magnetic strengths, eight diameters and 14 belt widths. **(100)**

ILLUSTRATIONS and condensed specifications on two models of crawler tractors, eight scrapers, nine rear-dump haulers and three bottom-dump models are contained in a 20-page booklet published by GM's Euclid Div. **(73)**

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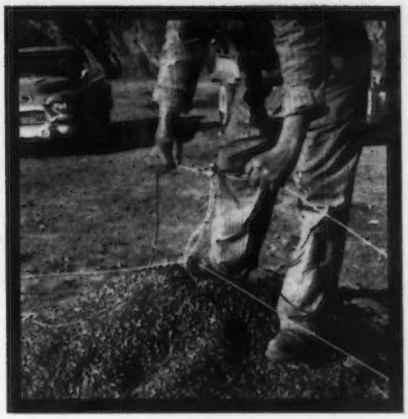

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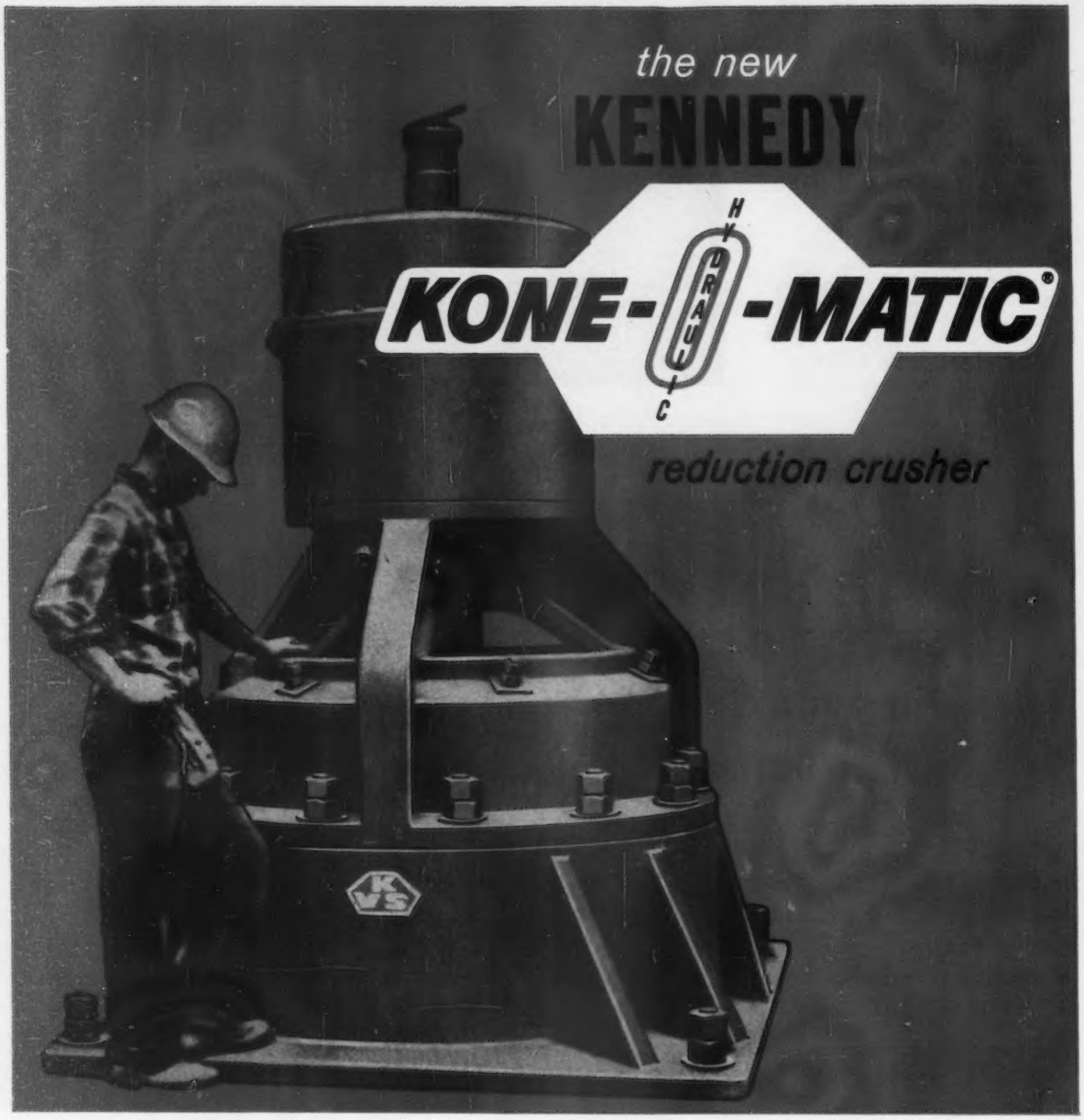

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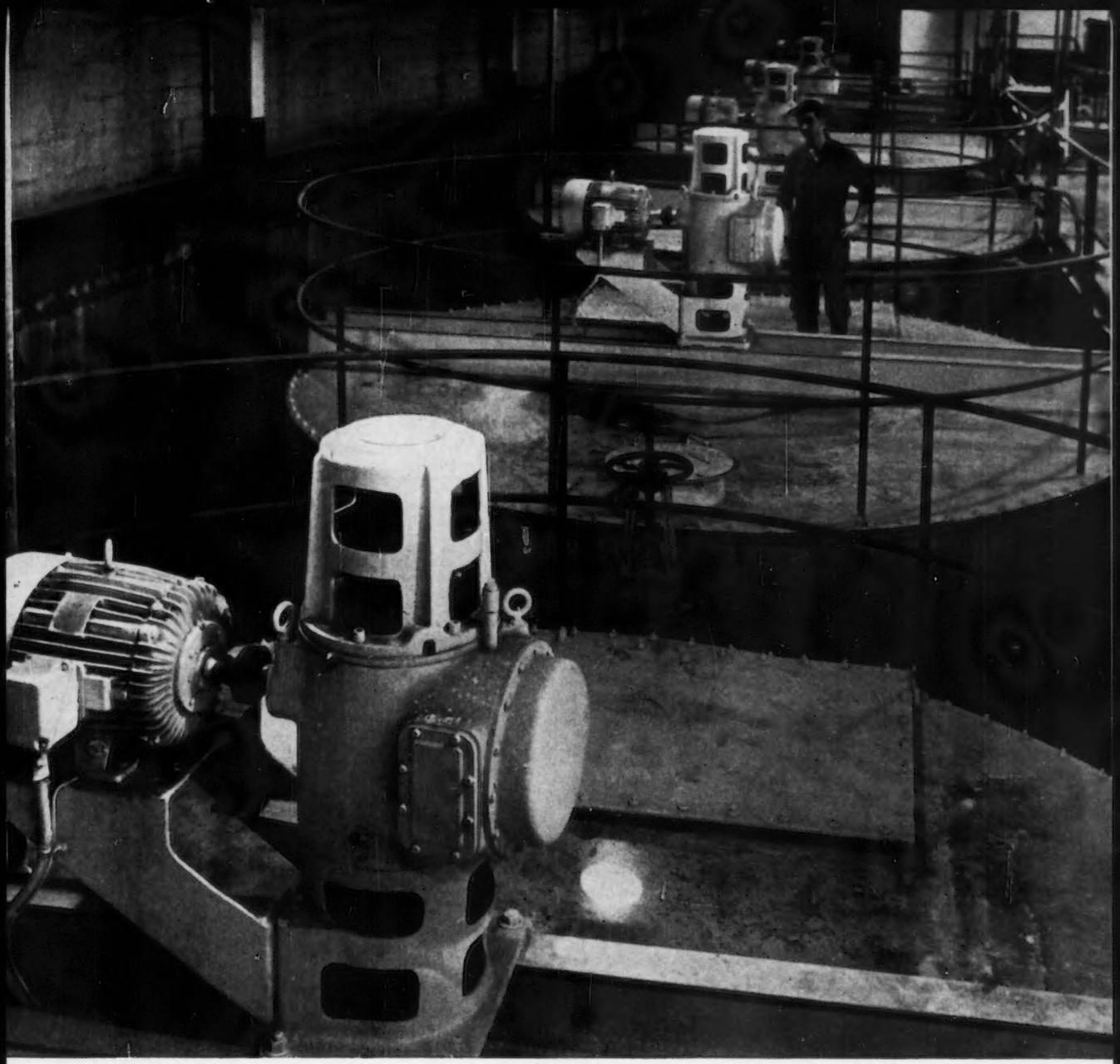


Eldorado Mining & Refining Company, Beaverlodge, Alta., Canada

Just right.

Not too much agitation—or the tender flocs of precipitate break down into a powder that can't be filtered.

Not too little, either. It takes a certain minimum level of controlled power to disperse the precipitating agent swiftly through each 16x18-ft. tank.

Our men know how much agitation is just right for this process. They can quickly figure out how much is just right for any of *your* fluid-mixing operations, too. This helps you get more out of your ore.

They can deliver LIGHTNIN Mixers that will do just exactly what you expect them to do—on a results-guaranteed basis. And keep doing it year after year after year.

Want to know more? Call in your LIGHTNIN Mixer representative (he's in Thomas' Register). Or write us.

Lightnin® Mixers

MIXCO fluid mixing specialists

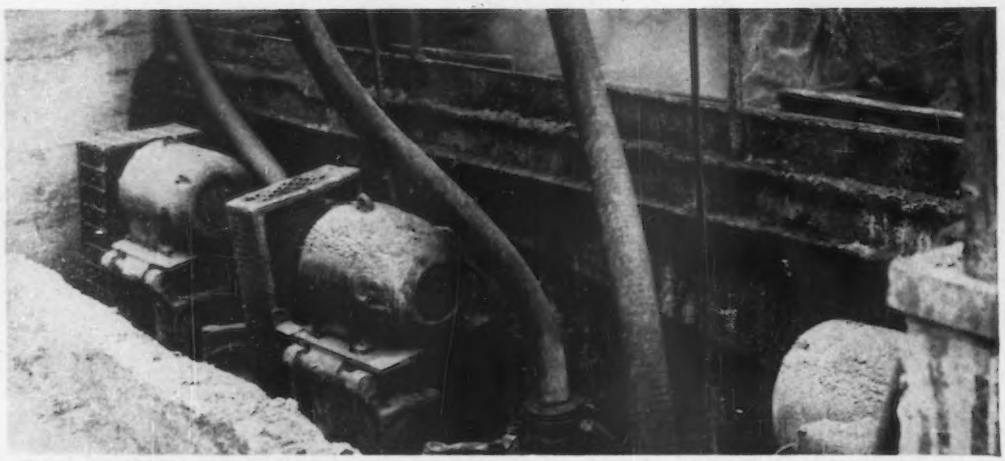
MIXING EQUIPMENT Co., Inc., 234-n Mt. Read Blvd., Rochester 3, N.Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 19, Ont.

In Europe: Lightnin Mixers, Ltd., Poynton, Cheshire, England

US RUBBER

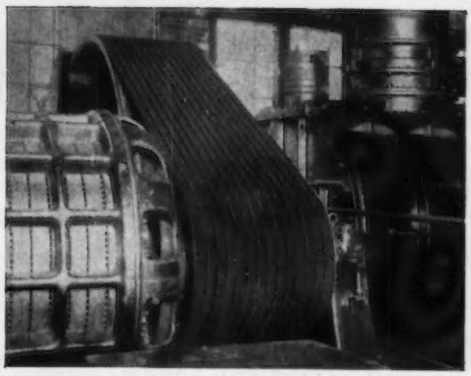
AT THE HEART OF INDUSTRY...



Union Carbide's Uravan Mill's need for flexible piping that stood severe abrasion without being chewed up was filled by U.S. Pilot® Pipe. This pipe is built to handle abrasive and corrosive materials such as calcined ore and sulfuric and hydrochloric acid. It's flexible, easy to install, won't build up... gives longer service life than metal pipe.

H 121

Name the mining operation and you'll find US Industrial Rubber Products there, willing and well able to handle the toughest assignments. Find out how and why these U.S. Rubber products can serve you better, cost you less and provide "minimum mining maintenance" throughout your whole operation.



Cut costs, reduce maintenance, avoid shutdowns. In mines across the country, U. S. Royal V-Belts power fans, pumps, compressors, generators, conveyors—equipment that demands the maximum in reliability for safety as well as profit. U. S. Royal V-Belts are known throughout industry for their exceptional length stability, uniformity, and long service on drives of all kinds and sizes.

VB 101

Withstanding pressures 100 lbs. greater than conventional fabric hose, this US Mine De-Watering Hose carries an average of 7,500 gallons of water a minute in keeping a crushing plant, located in the pit area of a gigantic metal mine, bone-dry. Its wirecord construction enables this hose to handle pressures up to 350 lbs. and still be flexible.

H 137

New U.S. SlurryKing takes loads up steeper grades, stops avalanching, even carries the fluid portion of slurries along with the solids. This belt lets you drain or retain fluids in slurries by merely changing conveyor and idler roller angles. SlurryKing's tough cover resists the severe abrasion of both wet and dry materials to retain the belt's hill-climbing ability indefinitely.

C B121

For every industrial rubber product need, turn to US. For Conveyor Belts, V-Belts, the original PowerGrip "Timing"® Belt, Flexible Couplings, Mountings, Fenders, Hose and Packings . . . custom-designed rubber products of every description. Discover why U. S. Rubber has become the largest developer and producer of industrial rubber products in the world. See your U. S. Rubber Distributor or contact US directly at Rockefeller Center, New York 20, N. Y.

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

United States Rubber

MECHANICAL GOODS DIVISION

CONVEYOR SYSTEMS 1600 MI. APART SPEED ORE SHIPMENTS TO U.S.

Specially designed Barber-Greene system utilizing unique hinged arch-type supports mechanizes shipping terminal for U.S. Steel subsidiary

Two Barber-Greene conveyor systems, located 1600 miles apart in South America, help speed manganese ore from a Brazilian mine to a shipping terminal in Uruguay where the ore is loaded into ships for delivery to U.S. steel mills.

The shipping terminal is operated by Compania Navigen Sucursal Uruguaya, a U.S. Steel subsidiary, and began operation in 1958.

Navigen Company officials say, "The Barber-Greene conveyor equipment at the Transfer Station has operated very satisfactorily and was well chosen." Navigen's Technical Director at Nueva Palmyra during installation reports: "Barber-Greene factory assembled terminals were a great help in erection, particularly due to the scarcity of skilled labor. And we got needed technical and engineering support from Barber-Greene personnel from initial planning through erection and operational stages."

Three conveyors at mine

The mine installation at Corumba, Brazil, operated under contract with another U.S. Steel subsidiary, consists of two tunnel conveyors plus a third barge loading boom conveyor that extends out over the river and is adjustable to river levels and barge heights.

At the shipping terminal at Nueva Palmyra, Uruguay, six Barber-Greene conveyors totalling 2,655′ unload barges, stockpile the ore and reclaim it for loading into ocean-going vessels. Stockpiling capacity totals 75,000 tons.

Design features

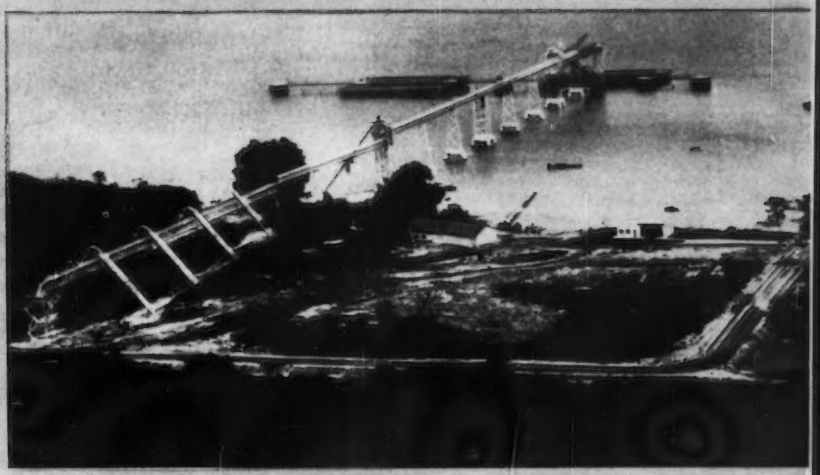
Unique design features: Giant hurricane-proof cantilevered supports that are clear of the stockpile and under which the stockpiling conveyor is hung; reversible belt on the longest conveyor in the system which permits use of the same conveyor for both stockpiling and reclamation operations; run-around system that allows ore to be moved directly from barges to ships when stockpiling is not necessary; and a cantilevered ship loading shuttle conveyor that can be positioned to handle ships of various widths.

The same engineering skill that designed this heavy-duty system to handle 156 lbs./cu. ft. manganese ore is ready to work for you, or your engineering firm. Your Barber-Greene conveyor specialist will gladly explain how standardized or specially engineered systems, or a combination of both, can bring increased efficiency, dependability and lower costs to your material handling problem.

View of inclined conveyor used to reclaim ore from stockpile at Nueva Palmyra. All belts in system are 30" wide and run at average 350 fpm speed. Some of the nearly 1,000 Barber-Greene heavy-duty roller-bearing idlers with 6" diameter rolls are visible here.

Ore from 75,000 ton stockpile is reclaimed by 515' tunnel conveyor fed by 33 gates. Material moves up inclined conveyor, over 854' reversing conveyor and passes over shuttle conveyor enroute to ore boats.

Overall view of terminal shows how whirly crane used to unload barges, hopper, 42" x 10' Barber-Greene belt feeder and tail end of first inclined conveyor are all located hundreds of feet offshore on a cellular dock.



Upper view of 746' stockpiling conveyor at Nueva Palmyra shows top cantiliver supports that resist winds up to 130 mph. Conveyor has traveling tripper that discharges incoming ore onto stockpile.

Send for New Idler Bulletin

New 44-page Idler Bulletin describes the more than 800 units available in the complete Barber-Greene line, tells how their years-ahead features bring longer life and greater economy to every job. Ask for your copy today.

Your belt conveyor equipment headquarters

Representatives in Principal Cities of the World

Barber-Greene BG

Main Office and Plant AURORA, ILLINOIS, U. S. A.
Plants in DeKalb, Illinois..Detroit..Canada..England..Brazil..Australia

CONVEYORS • LOADERS • DITCHERS

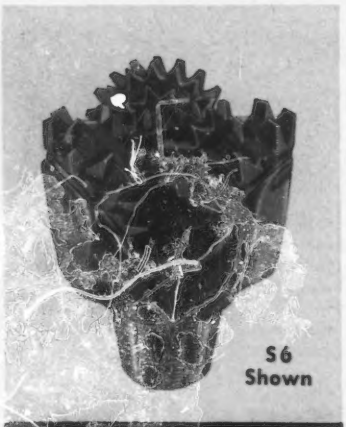
ASPHALT PAVING EQUIPMENT

For Lowest Drilling Costs, Specify...

Security®

SUPER-AIRE BLAST HOLE BITS

for your drilling requirements



S SERIES — For Soft Formations* Designed to effectively drill the complete range of softer formations . . . shales, soft sandstone, soft limestone. Maximum offset of cones for greatest twisting — tearing action and long teeth assure fastest penetration rates. Self-cleaning action of cutter designs and placement of air courses prevent balling up and permit rapid removal of loose particles from bottom of hole.

M SERIES — For Medium Formations* General purpose bits for fast drilling of medium hard limestone, shaley limestone and other medium formations. Moderate offset is employed to increase penetration rates. Additional gage protection is provided by "T" tooth designs where formations are abrasive. Special cutter features, combined with sturdy tooth design, of these versatile bits, offer greater strength to withstand heavier drilling weights in harder formations.

H SERIES — For Hard Formations* Especially designed for use in harder formations, such as dolomite, hard limestone, traprock. Sturdy teeth, closely spaced on extremely strong cones, are capable of withstanding heaviest drilling weights. Gage tooth configurations are available with "L", "T" and full webb sections for hardest and most abrasive formations that can be cut with steel toothed bits. True rolling, non-offset cutters and extra large bearings assure longest life.

H SERIES INSERT TYPE — For Extremely Hard Formations* Tungsten carbide insert bits are available in three types for hardest, most abrasive formations such as granite, etc. An exclusive Security feature of this series is the special placement of compacts for full gage protection and maximum gage cutting. H8 series features large compacts spaced on raised cutter structures for maximum ventilation and best penetration rates. H10 type, designed for hardest formations possible to be drilled, employs closely spaced large compacts in a "hunting tooth" pattern to avoid tracking and to maintain full coverage of bottom hole. H10 features rugged spear points with spirally placed compacts. H9 series is mid-way in hardness range between H8 and H10. Security insert bits have conical shaped points on compacts insuring faster penetration rates.

Security SUPER-AIRE bits feature extra-large, self-cleaning screens, maximum capacity bearings, and air passages to bearings unrestricted by ball retainer plugs as in other bits.

**Jet air or regular air types available. Send for catalog.*

Security®
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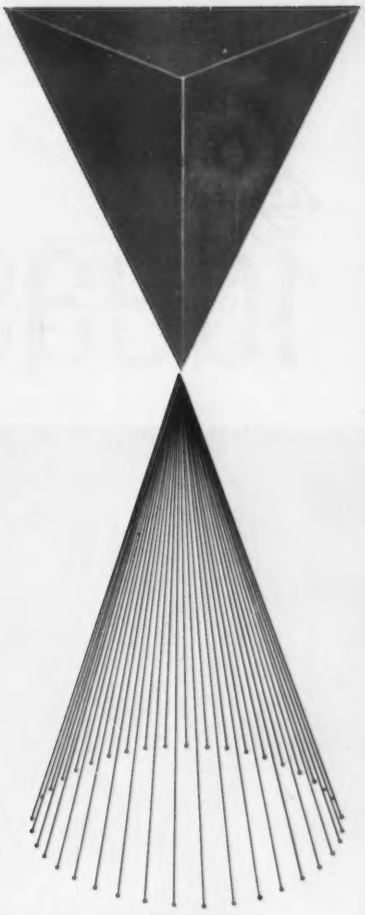
DRESSER INDUSTRIES, INC.



SOLID EXPERIENCE *plus* INGENUITY in engineering

and construction. Vital to your new plant's maximum profitability —and KE is headquarters for both!

To years of major plant design and construction experience, KE adds the other vital ingredient—ingenuity. Ingenuity in design and in construction, to give you a better plant, sooner. Ingenuity that ranges from basic innovations to sophisticated analysis by KE computers in such applications as profitability and operations studies, critical path scheduling, linear programming, simulations by Monte Carlo methods, process burden and materials handling calculations, heat balance and steam flow calculations, and reactor design considerations. In Steel, in Minerals, in Power Generation, in the Nuclear field—Kaiser Engineers' experience and achievements are substantial. A call from you will bring a specialist in your field to summarize what KE has done for others, can do for you.

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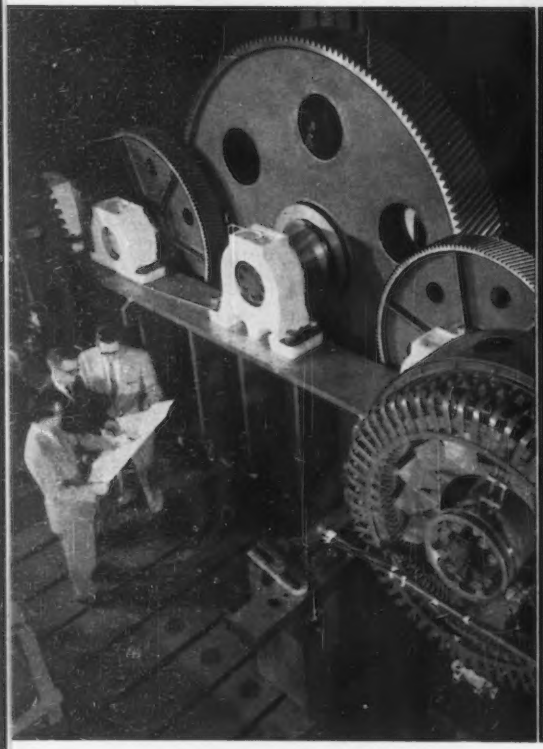
ideas and news:



Full-load demonstration proves 98%-plus drive efficiency: A-C factory engineers recently demonstrated the high efficiency of TWINDUCER grinding mill drives. It ranged from 98.48% to 98.52%. This exclusive twin motor drive system divides mill load electrically, saves space, installation costs, minimizes gear wear.

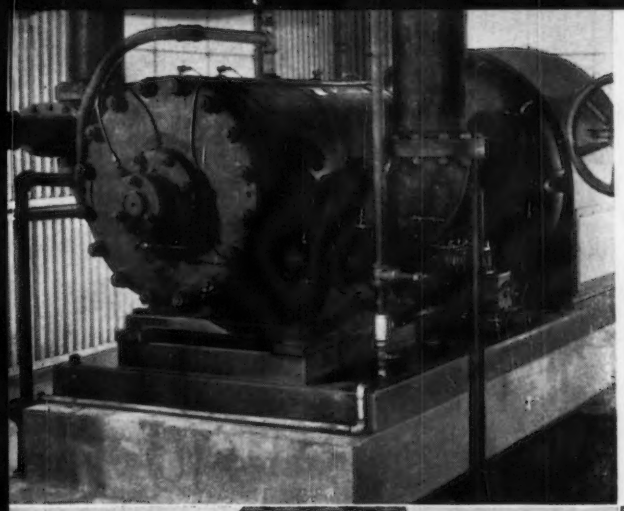
From low-grade ore . . . ideal blast furnace feed: Now economically processing 1000 tpd of beneficiated, finely-powdered concentrates from low-grade iron ore, the new GRATE-KILN system produces these iron-rich, ready-for-the-blast-furnace pellets. It utilizes a unique method of heat recovery and process control. A specially-designed A-C vibrating screen receives the pellets from the balling drum . . . permits only properly sized balls to pass into the kiln.

Which of these productive ideas could be working for you?

A grinding mill drive that saves power and space. A system that makes low-grade ore valuable. A vacuum pump that maintains constant efficiency. These examples demonstrate the extra value that is standard with A-C...the greater efficiency and added productivity which are yours when you buy A-C products, systems and services. Call your Allis-Chalmers representative for details on "worth-more" features. Or write Allis-Chalmers, Milwaukee 1, Wisconsin.

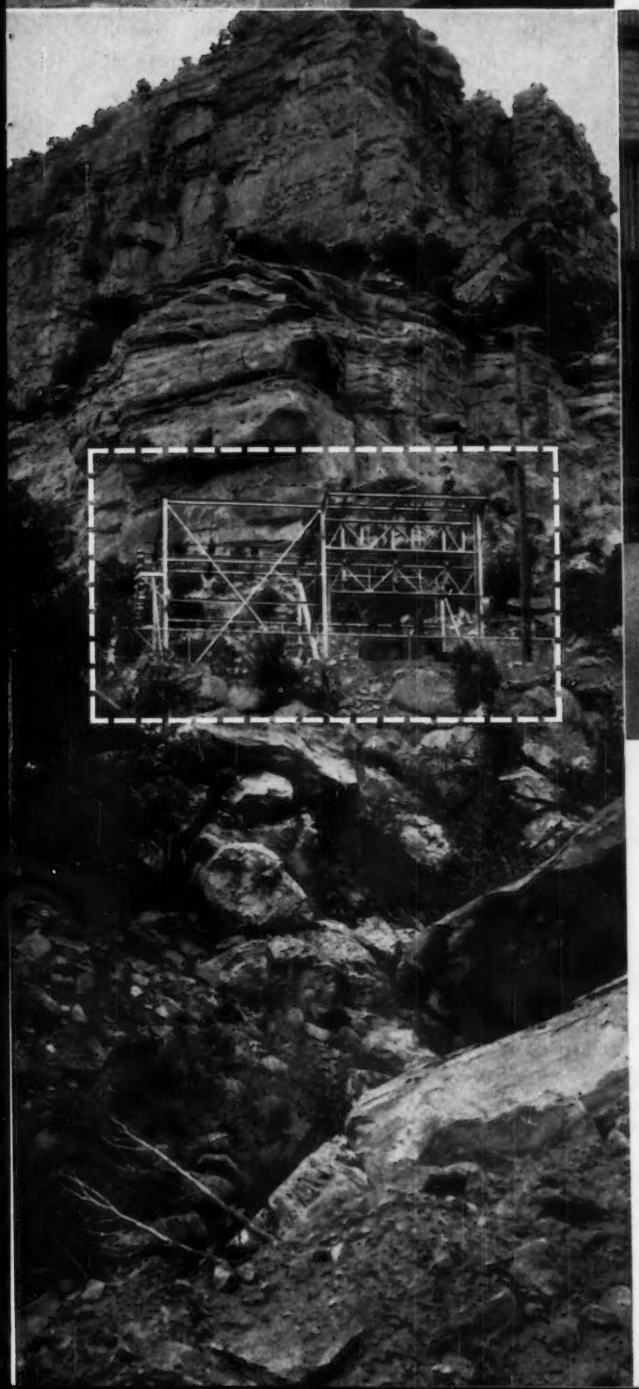
A-1552

Twinducer, Grate-Kiln and *Ro-Flo* are Allis-Chalmers trademarks.



Constant vacuum . . . year after year: RO-FLO vacuum pumps with sliding-vane rotary design eliminate operating losses inherent in reciprocating machines. Centrifugal force keeps vanes in close contact with cylinder walls, automatically compensating for wear. In addition, few moving parts required reduce wear, simplify maintenance.

Lowest height, easiest access 5-kv metal-clad switchgear on the market. Just 72 inches high. You get eye-level instrumentation, shoulder-height accessibility of component parts. Other outstanding advantages: front-accessible current transformers; maximum compartmentation and dead-front construction for greater safety; full-panel metering; rapid, one-stroke breaker insertion. Choice of stored energy or solenoid operation.



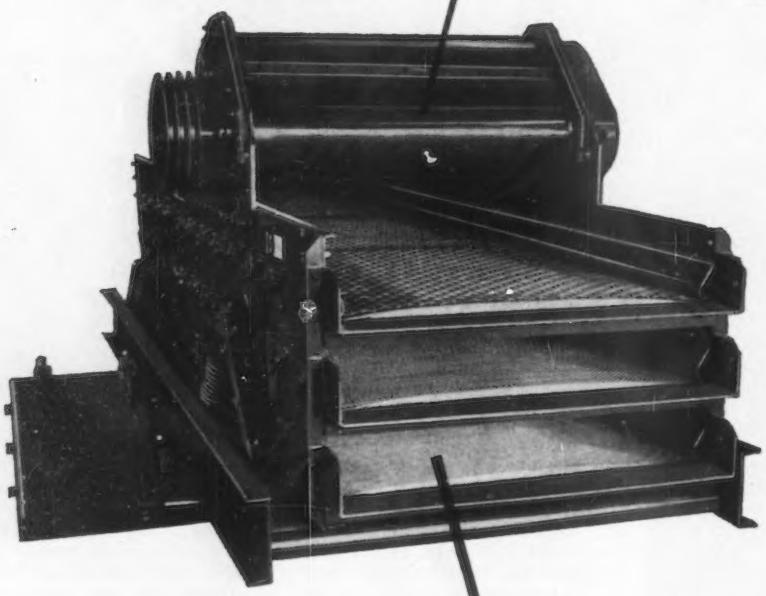
Reliable performance that's one mile high: This A-C substation has completed about five years' service 6546 feet up the remote Wasatch mountains of eastern Utah. Equipment survived rugged transportation up the mountain side on steel skids or trucks over rough bulldozed road. One switchgear fell from truck but was not damaged beyond a few dents. Picked to give dependable performance in this inaccessible, practically unserviceable location, A-C substation has proved out well beyond expected performance.

ALLIS-CHALMERS PRODUCTS: Look to Allis-Chalmers for compressors, controls, crushers, earth-moving equipment, electrical distribution equipment, engines, generators, industrial systems, kilns, lift trucks, mills, motors, pumps, rectifiers, screens; thermal, hydro and atomic electrical generating equipment; tractors, transformers, unit substations.

ALLIS-CHALMERS

NEW SIMPLICITY HORIZONTAL VIBRATING SCREEN

CONVEYS AND SCREENS material in mining and gravel plants where minimum headroom is a problem



Simplicity Engineering Company has built a new horizontal vibrating screen, Model OA-95, designed to operate in mining and crushed stone plants where headroom is the governing factor. In this type of operation, it is necessary to both convey the oversize material and screen the undersize material. To do these two jobs successfully, the rugged shaft assemblies have two full length, cast alloy off-set shafts. These counter-rotating shafts, geared together, with heavy duty precision bearings that run in oil, provide the extra power needed to operate large screen areas on an efficient basis.

The Model OA-95 is equipped with a straight line deck designed to withstand the punishment of severe impact and loading stresses. The one-piece deck has all-welded construction and is stress relieved in an electric furnace to insure greatest strength and durability.

Available in sizes from 4′ x 10′ to 4′ x 16′, the new, 3-deck screen can be quickly converted to a two-deck unit by removing the center deck.

For complete information on the OA-95 Horizontal Vibrating Gravel Screen and other screening equipment, scalpers, feeders and feeder grizzlies manufactured for the gravel and mining industries, write to Simplicity Engineering Company.

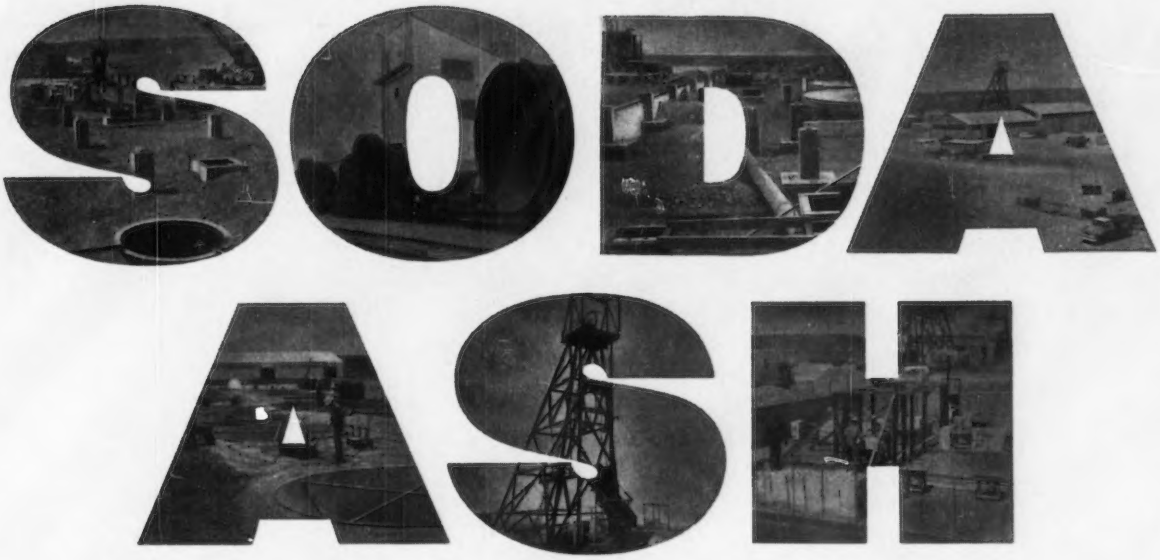
Simplicity
TRADE MARK REGISTERED

ENGINEERING COMPANY • DURAND 4, MICHIGAN

SALES REPRESENTATIVES IN ALL PARTS OF THE U.S.A.
FOR CANADA: Simplicity Materials Handling Limited, Guelph, Ontario.
FOR EXPORT: Brown & Sites, 50 Church Street, New York 7, N. Y.

the new Wyoming source of

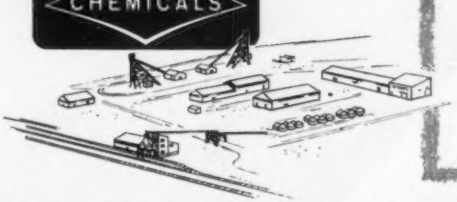
SODA ASH



with Stauffer nationwide service facilities!

The completion of Stauffer's new Wyoming plant to supplement existing West End facilities will expand the market for Stauffer soda ash into areas served traditionally by Stauffer nationwide offices in supplying industrial chemicals. The large traffic department experienced in nationwide distribution problems can effect efficiency and economy in the transport of bulk or bagged soda ash from Stauffer's two natural sources. Let us suggest practical ways you can be supplied economically at your point of consumption. Simply address the coupon below and mail.

Stauffer CHEMICALS



WE ARE INTERESTED IN KNOWING THE BENEFITS TO US OF STAUFFER AS A SODA ASH SUPPLIER.

YOUR NAME_____

COMPANY_____

ADDRESS_____

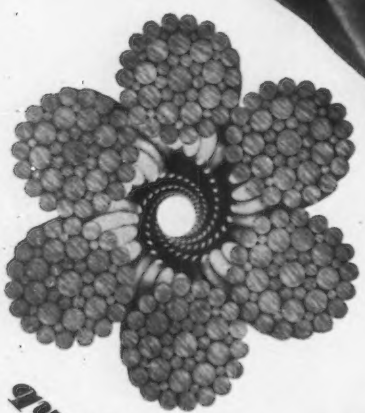
CITY_____ STATE_____

Please mail to West End Chemical Co., 636 California Street, San Francisco, Calif.

WEST END CHEMICAL COMPANY • DIVISION OF STAUFFER CHEMICAL COMPANY

SAN FRANCISCO, 636 CALIFORNIA STREET • CHICAGO, PRUDENTIAL PLAZA • ST. LOUIS 19, P. O. BOX 48

We put a lot of work into it — You get a lot of work out of it



quality inside and outside

Here are two "close-ups" of Roebling Royal Blue Wire Rope which show in part where your savings come from . . . uniformity of structure. Invisible, but equally important, is Royal Blue's *extra* high tensile strength. All the way through, Royal Blue pays off for you on every kind of wire rope job. Find out more from your wire rope distributor, or write for free booklet to Roebling's Wire Rope Division, Trenton 2, New Jersey.

ROEBLING

Branch Offices in Principal Cities
John A. Roebling's Sons Division
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This mark tells you a product is made of modern, dependable Steel.

When we say fast delivery of grinding balls . . . . . we mean it!

No delivery problems. We don't really shoot USS Grinding Balls out of a cannon. It takes too long to load them! We deliver them in a hurry—all the balls you need, packed and loaded as you specify, exactly when you need them.

No selection problems. You can order from a complete stock of USS Carbon-Manganese and USS Alloy Steel Balls, in a range of sizes from ¾" to 4".

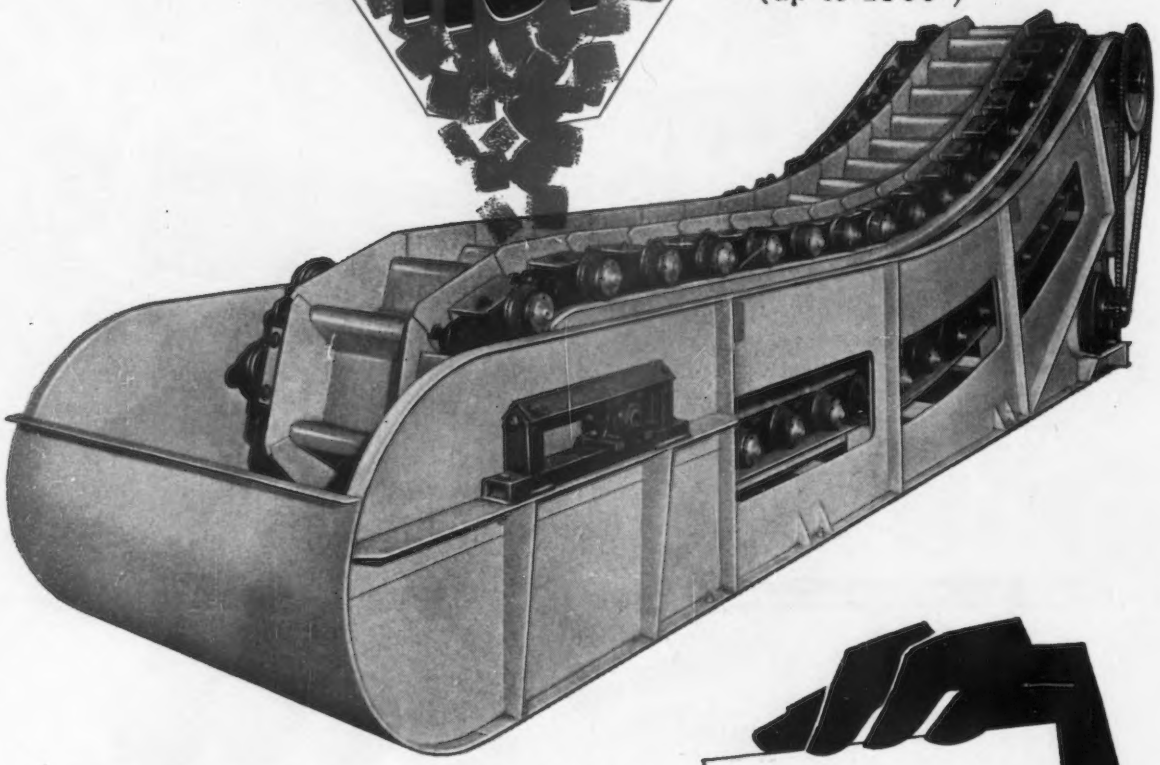
No performance problems. USS Grinding Balls are hard, tough, and uniform from ball to ball and load to load. Recently completed hardness surveys under direction and control of USS Research Center proved that maximum depth of hardness consistent with toughness is provided by our product in both carbon and alloy grades in all sizes. You cannot buy a better ball for your purpose!

Solve your grinding ball wear problem by calling our nearest Sales Office or United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

United States Steel Corporation • Columbia-Geneva Steel Division • Tennessee Coal & Iron Division • United States Steel Export Company

USS TRADEMARK United States Steel

when you want a cool solution to a HOT problem (up to 1900°)



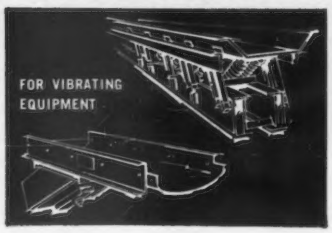
Here's your dependable answer to the problem of efficiently handling hot bulk materials... Rex Deep Pan Conveyors. Whether your heat processing involves sintered, calcined, noduled or briquet materials, these rugged, heavy-duty conveyors provide maximum dependability and service life. The large-surface, deep carbon steel pans provide maximum heat transfer. Chains and outboard rollers are isolated from the maximum temperature heat zone to prevent heat damage on these working parts.

Rex Conveyor design with square through rods connecting the chains assures rigidity and equal load distribution. Wear is actually confined to the heavy-duty outboard rollers. This design permits easy servicing without need for disassembly of chain or conveyor.

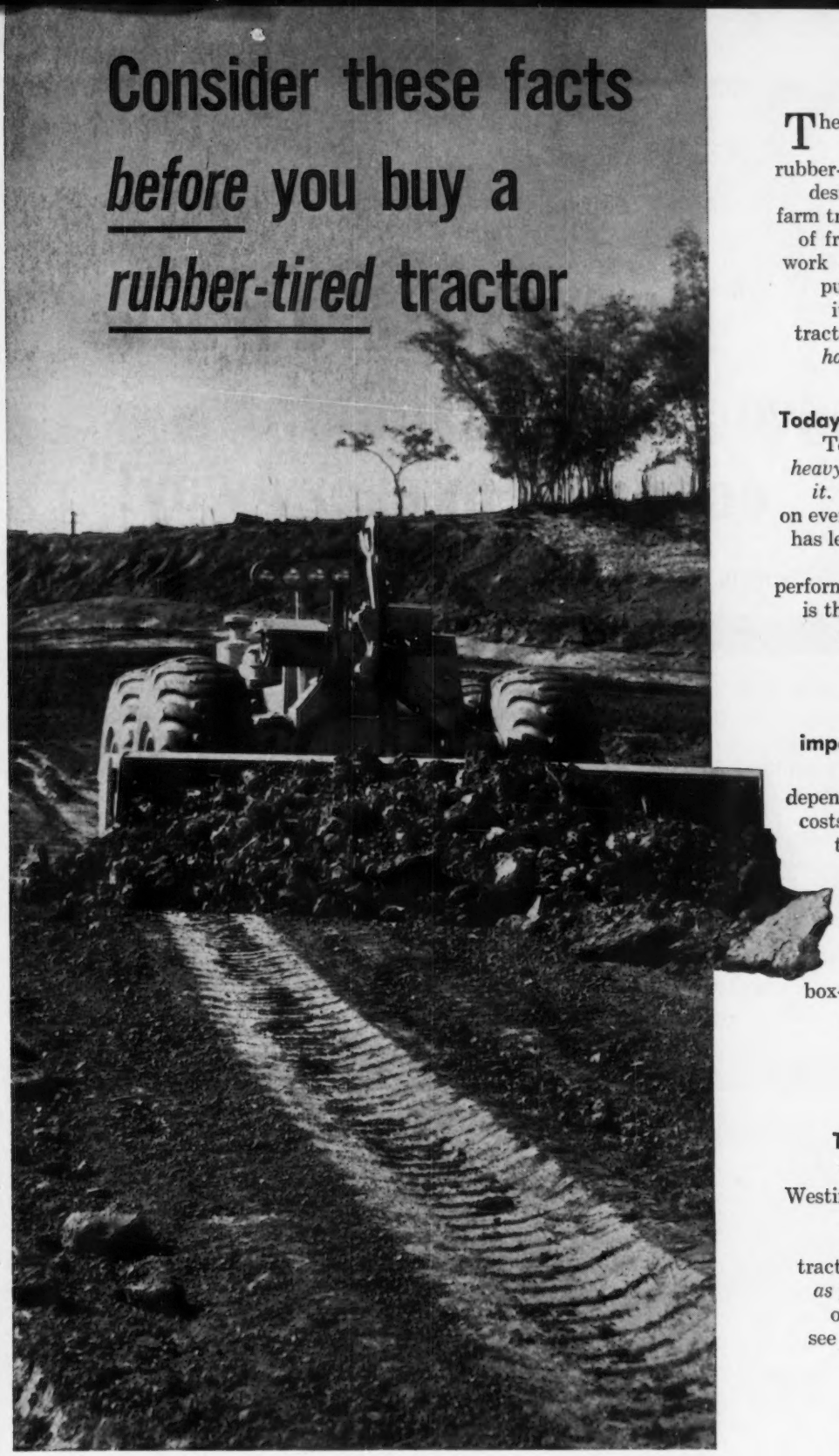
Why not have Rex Engineers help you solve your hot materials handling problems. Write CHAIN Belt Company, 4679 W. Greenfield Ave., Milwaukee 1, Wis. In Canada: Rex Chainbelt (Canada) Ltd., Toronto and Montreal.

REX® CHAIN BELT COMPANY

INDUSTRY'S HELPING HAND



Consider these facts *before* you buy a *rubber-tired* tractor



The past few years have seen the introduction of a number of rubber-tired tractors. Some are new designs based on experience with farm tractors. Some are conversions of front-end loaders. But if your work calls for heavy-duty dozing, pushing, towing, stockpiling . . . it would pay you to invest in a tractor that is *proven and built to handle this type of assignment.*

Today's LeTourneau-Westinghouse Tournatractor® has *15 years of heavy-duty field experience behind it.* Knowledge gained from work on every possible tractor application has led to continuous improvement in mechanical efficiency and performance. Result: Tournatractor is the *only* thoroughly *job-proved* rubber-tired tractor available for heavy-duty work.

Consider these other important LW tractor features:

• Anti-friction drive for dependability and low-maintenance costs • Exclusive LW single-stage torque converter . . . proved on thousands of installations • Instantaneous, "non-stop" gear selection with speeds to 17.2 mph . . . for maximum output • Husky, all-welded box-type frame and oil-enclosures provide unique protection for its moving parts • Electric blade control for fast, positive action.

The facts boil down to this:

When you buy a LeTourneau-Westinghouse Tournatractor, you're getting a proven machine. Remember, too, you complete tractor jobs faster . . . in fact, *twice as fast* as slower-moving crawlers on 85% of your work. Why not see for yourself? We'll be happy to demonstrate.

CT-2429-G-1r

LW

LeTOURNEAU-WESTINGHOUSE COMPANY, PEORIA, ILL.
A Subsidiary of Westinghouse Air Brake Company *Where quality is a habit*

"Our 48 Ford Trucks have given maximum economy in every way!"

says Fred Newkirk, Manager of Materials Transportation Company, Inc., Corpus Christi, Texas

"We are using Ford Trucks exclusively because they provide important savings—starting with a lower initial expenditure. We estimate that each Ford costs us about $1,500 less than other makes of comparable size and capacity. Our maintenance and repair costs are less, too. The greater parts interchangeability on Ford Trucks makes it possible to reduce our parts inventory by about 50%; this frees $2,500 of working capital. And in operating expenses, we save on gasoline because our Fords deliver an extra ½ mile per gallon.

"They have proven more durable, too. For example, our 1958 Ford F-1000 has logged over 160,000 miles without even having the heads or pan off. We expect 200,000 miles from these Super Duties before a major overhaul. Some of our 1955 and 1956 Ford F-900's still have their original brake linings after 300,000 miles.

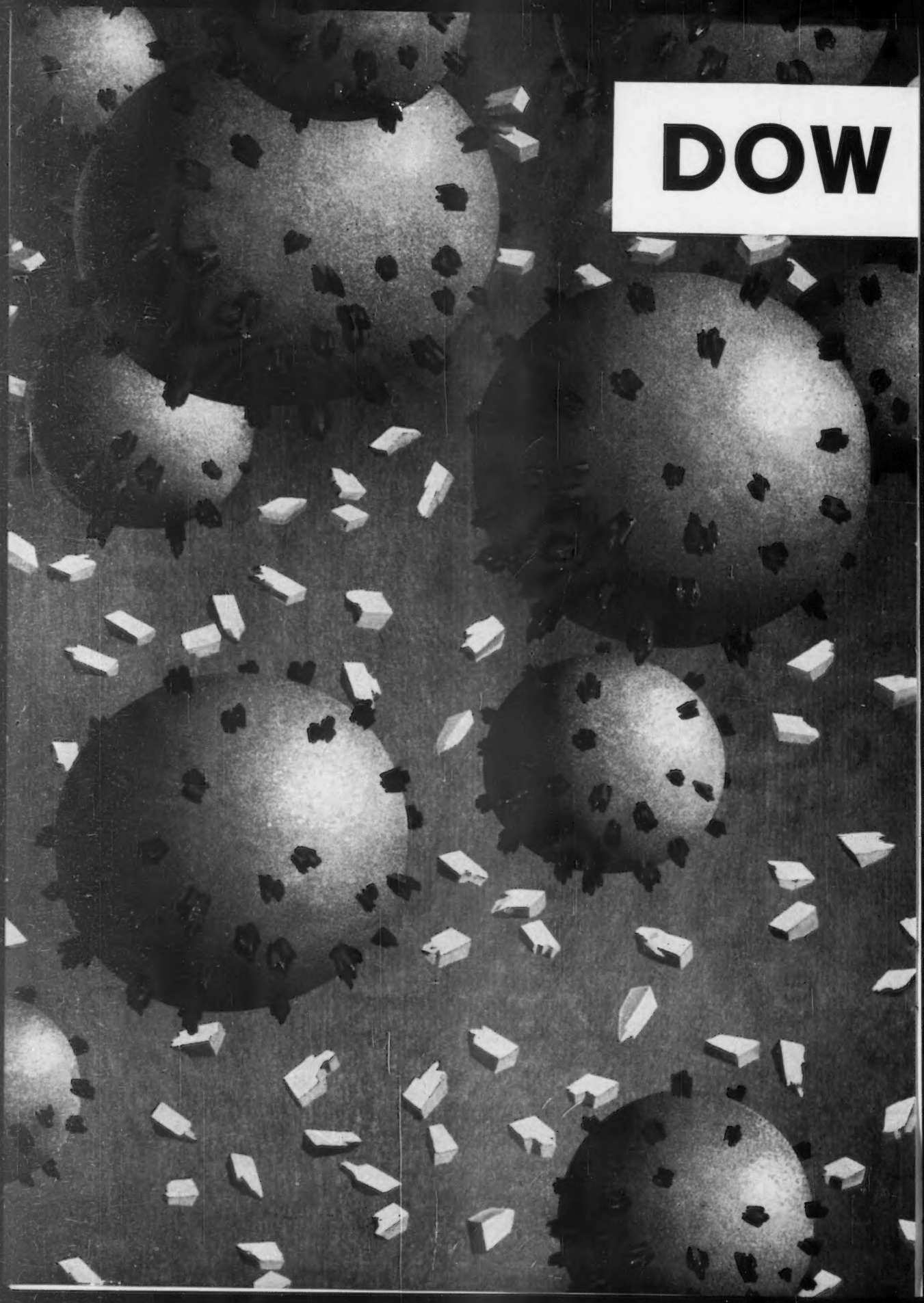
"Our trucks operate six days a week, and the average fleet mileage is 51,000 miles per week. We haul 48,000-lb. payloads of bulk cement or 37,760-lb. payloads of sack cement for Halliburton Portland Cement Company. Our drivers are also very enthusiastic about these new Ford Super Duties. They report that with 72,000-lb. grosses Fords are smooth riding and easy to handle."

Solid testimony that Ford's full-time economy only starts with low price!

FORD TRUCKS COST LESS

PRODUCTS OF Ford MOTOR COMPANY

HALLIBURTON
FORD
J-27244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mining chemicals

Z-200

BETTER COPPER-PYRITE SELECTIVITY, LOWER LIME COSTS WITH Z-200

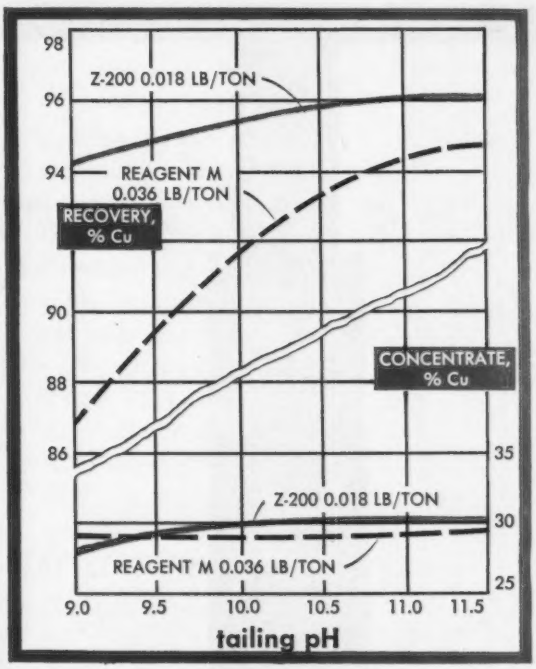
Mill-scale separations of copper from copper-pyrite ores show that Z®-200 flotation agent is without doubt the most selective copper or copper-activated zinc mineral collector available to flotation metallurgists today.

Z-200 flotation agent is a *water-insoluble liquid* stable in both acid and alkaline pulps. Chemically, it is a dialkylthionocarbamate and offers metallurgists an entirely new structure to work with.

Since Z-200 is more selective against pyrite than any other collector, it requires only a minimum amount of control to smooth out operational fluctuations and ore changes. Also an advantage is the fact that an excess of Z-200 floats substantially *no* free pyrite, especially in lime alkaline pulps above pH 9.

On many ores, the use of high lime alkalinity in zinc flotation results in excessive gangue carry-over into the concentrate. Z-200 provides an excellent answer by lowering lime requirements. In addition, tests with Z-200 in zinc flotation at a pH of 9.5 produced a 50% zinc rougher concentrate—a big jump over the usual 29% produced at the same pH with the standard xanthate. So where lime costs at a particular location are a factor, or where multiple cleaning of the concentrate at the mill is prohibitive, Z-200 should be evaluated.

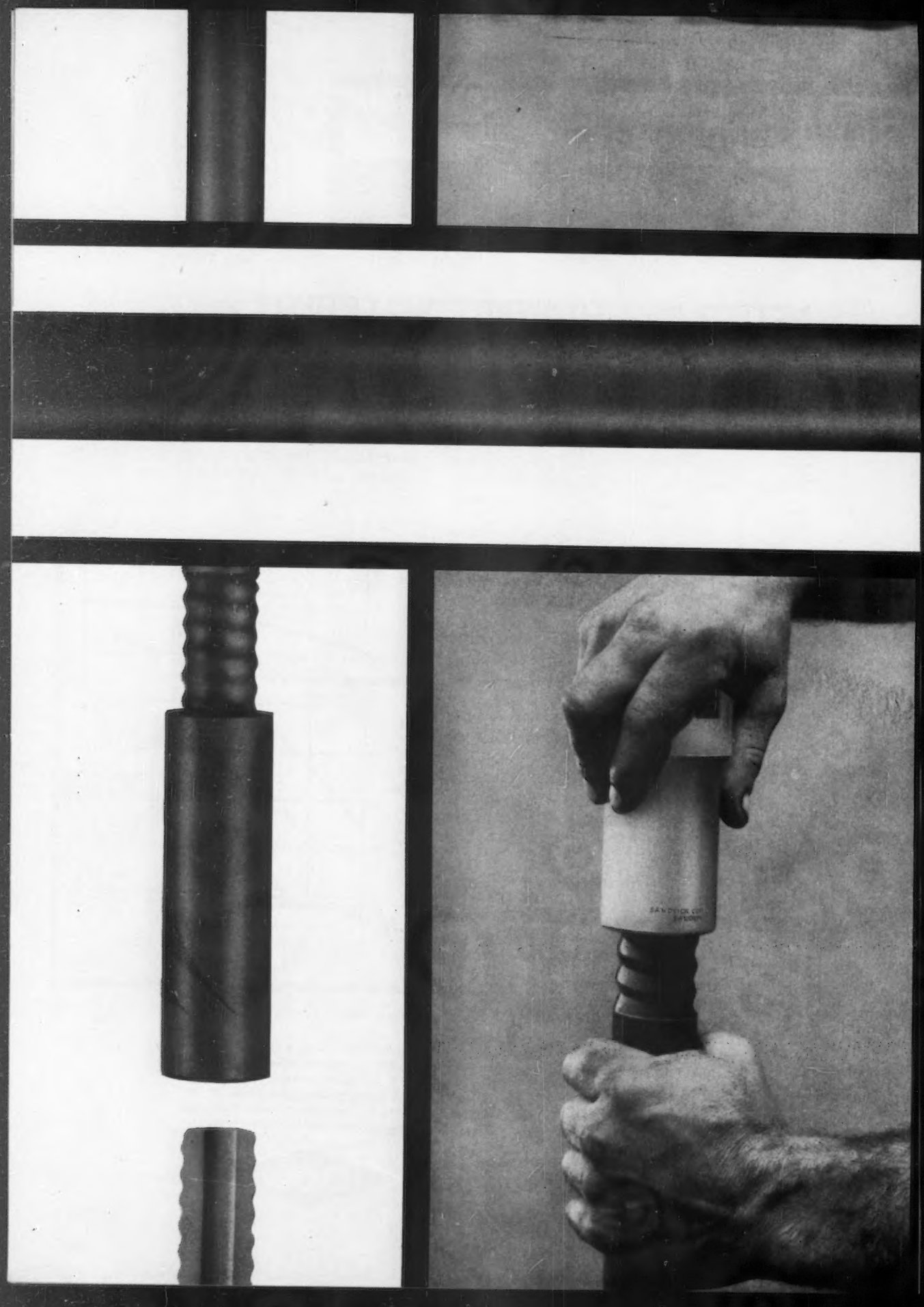
Compared to other copper and copper-activated zinc collectors, Z-200 flotation agent is unusually powerful and smaller-than-usual amounts are required. On many ores, Z-200 has sufficient frothing characteristics to provide a reduction in frother costs.



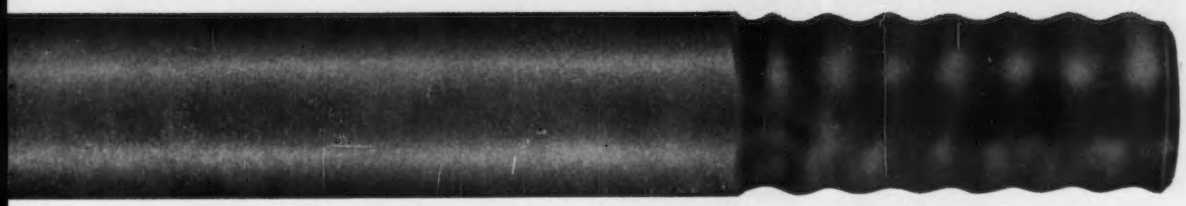
Comparison of Z-200 with standard collector on high-pyrite copper ore

Since ores have a way of changing just when you have everything going nicely, Dow maintains a special group of mining and milling experts who can be extremely helpful if problems arise. Their services are available either in writing or in person. They will be happy to assist you in any problem having to do with mining chemicals. For a copy of our new digest *Chemicals for the Mining Industry* write to THE DOW CHEMICAL COMPANY, Abbott Road Buildings, Midland, Michigan, Attn: Chemicals Merchandising Dept. 752BD12.

THE DOW CHEMICAL COMPANY DOW Midland, Michigan



Coromant steel with a SMOOTH PROFILE ...the combination that cuts drilling costs!



Smooth profile Sandvik Coromant "Rope Thread" steel is designed that way for a reason—with a pitch of just two turns to the inch to assure easy uncoupling. Where saw-tooth threads fail, smooth profile Coromant "Rope Thread" allows no starting point for fractures. Combine this with Coromant's cold-rolling, shot peening and SR anti-corrosion processes—and you get fewer broken rod ends and couplings. Consistent high quality, steel after steel, that assures less down time...lower cost per foot drilled. *Then,* when most steels are thrown away, you re-thread Coromant (without heat treatment) and put it back to work! Offered in all popular sizes: 1", 1¼", 1½", 2".

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It takes 125 millionths of an inch and just 60 seconds to measure Caterpillar engine quality

1. Remove the plunger from the fuel injection pump of a Cat Engine.

2. Hold the plunger in your hand for 60 seconds.

3. In that minute, the heat from your hand causes the plunger to expand enough so that it can't fit the barrel.

This shows the close tolerance and refinement built into Caterpillar Engines

Certainly, we could design a fuel system to less exacting tolerances. It would probably operate satisfactorily . . . for a while. But it would need periodic maintenance, overhaul and adjustment.

Caterpillar engineers feel that an engine owner should be free from constant tinkering and adjustment. He should also be assured that the system will deliver the quantity of fuel needed by the engine from cycle to cycle and from cylinder to cylinder.

That's why the Caterpillar designed and manufactured fuel system is held to such close tolerances. "Shade tree mechanics" won't find any field adjustments to make and it will operate practically trouble and maintenance free for the life of the engine provided clean fuel, free from contaminants, is always used.

Quality like this, throughout the engine, is available when you specify Caterpillar. It will be worth your time to investigate the new Caterpillar line of high-output diesel and natural gas engines that give you more horsepower per pound per dollar.

Industrial Engines—Diesels to 950 HP . . . natural gas to 720 HP . . . all-new 1960 and 1961 designs . . . attractively priced.

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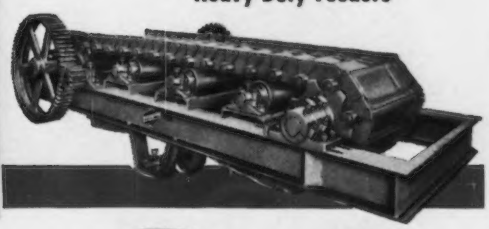
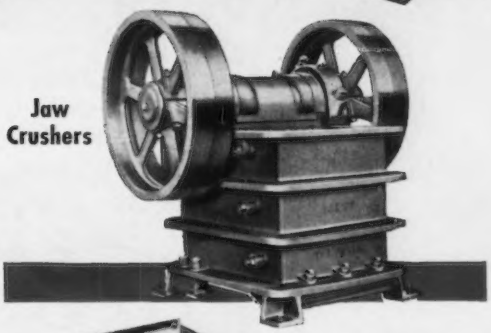
EQUIPMENT FOR MINES

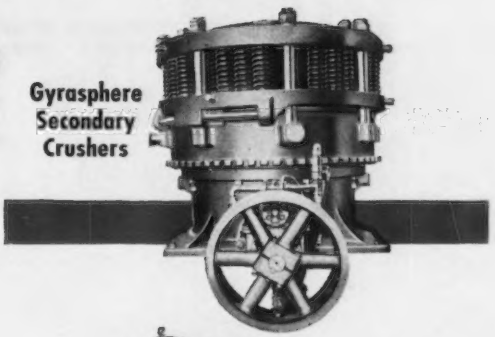


Heavy-Duty Feeders

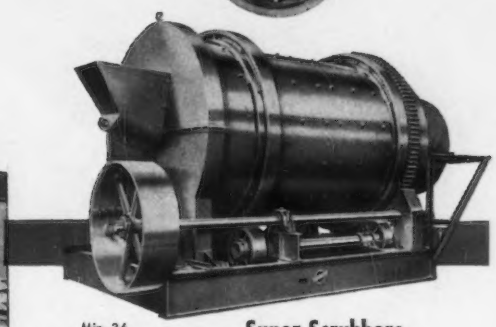


Jaw Crushers

Vibrating Screens



Gyrasphere Secondary Crushers



Min. 36

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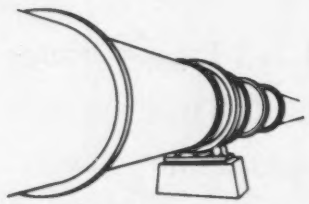
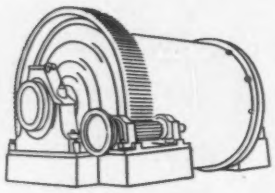
The only moving part on the STATIC CONTROL system is the operator's hand on the controller!

TRAYLOR EQUIPMENT

for the mining and process industries

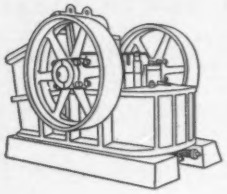


TRAYLOR ROTARY KILNS AND SLAKERS . . . the excellence of design and engineering of Traylor kilns is a result of over 58 years' experience in the manufacture of specialized machinery for the mining and process industries. Kiln shells are automatically welded of heavy steel plate. Alignment is maintained by easily adjusted supports. Full-floating type riding rings are of forged or cast steel, mounted on machined pads. Steel main gears and pinions are machined on a special gear generator. Kilns are designed and engineered to meet your specifications. Traylor has the most extensive research facility now available in the industry to insure delivery of process-perfected equipment to you.

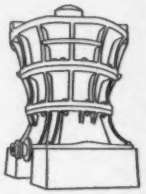


TRAYLOR BALL AND COMPARTMENT MILLS . . . **BALL MILLS** in both overflow and diaphragm discharge types have shells of welded steel with detachable heads of cast steel.

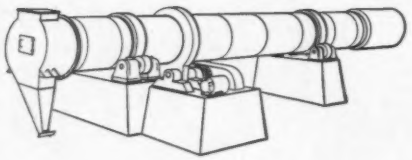
COMPARTMENT MILLS . . . partitioned by slotted diaphragms, these mills allow progressive reduction of products as it passes through different grades of grinding media within the mill, thereby reducing the amount of handling necessary in product reduction.



TRAYLOR JAW CRUSHERS . . . feature the original curved jaw plates for greater capacities at finer settings and longer life of the wearing plates. The swing jaw is made of cast steel of extra heavy design and the pitman shaft is of annealed open hearth forged steel, for lightness with great strength. Maintainence and inspection are simplified by the design which makes all parts readily accessible.



TRAYLOR GYRATORY CRUSHERS . . . Traylor is world famous as the manufacturer of giant 60″ gyratory crushers, secondary reduction crushers and fine reduction crushers. Crushers are designed with Traylor's original non-choking, self-tightening bell heads and curved concaves for large tonnage of small product and uniform size with a low percentage of waste and fines. Power applied as a direct crushing force offers greatly reduced power requirements at every setting.



TRAYLOR COOLERS . . . manufactured in diaphragm and multiple tube design, receive the same care in design and construction as Traylor kilns.

TRAYLOR SLURRY FEEDERS AND TABLE FEEDERS . . . **SLURRY FEEDERS** are self contained, fully closed ferris wheel type feeders . . . accurately supply a constant volume of slurry to kilns and mills. Single welded tank and hopper units are available in sizes from 36″ to 84″.

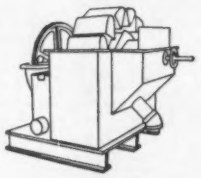
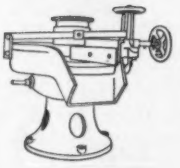


TABLE FEEDERS . . . accurately regulate the flow of material to mills, kilns and dryers. The revolving table receives material at its center from an adjustable feed spout. Feeders available from 2′ to 10′ in diameter.



See Pit and Quarry Handbook for details and specifications.

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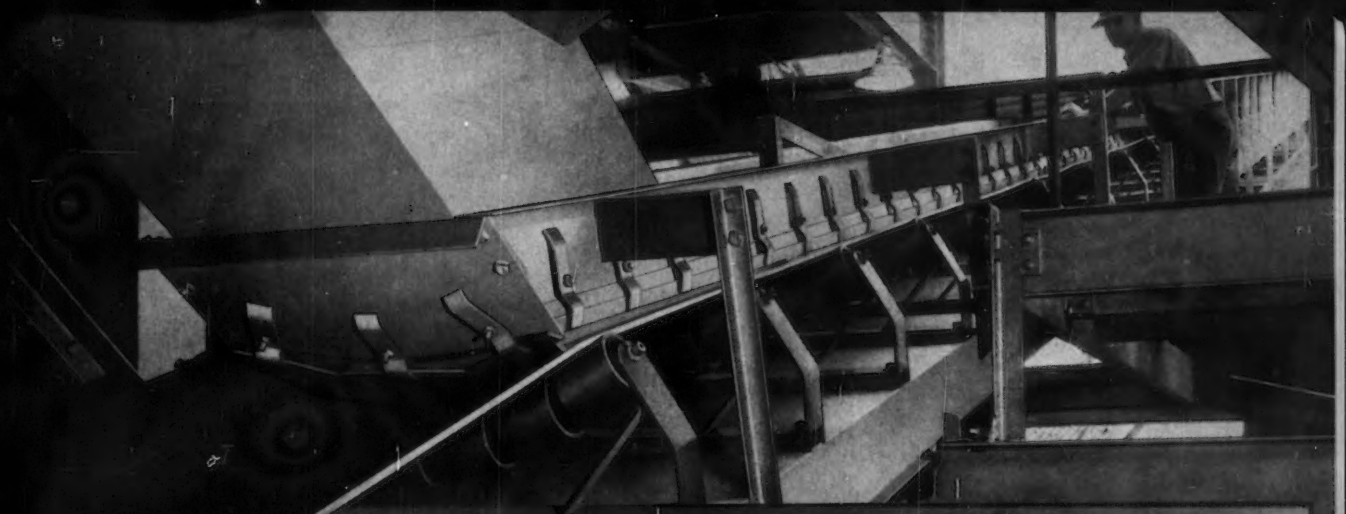

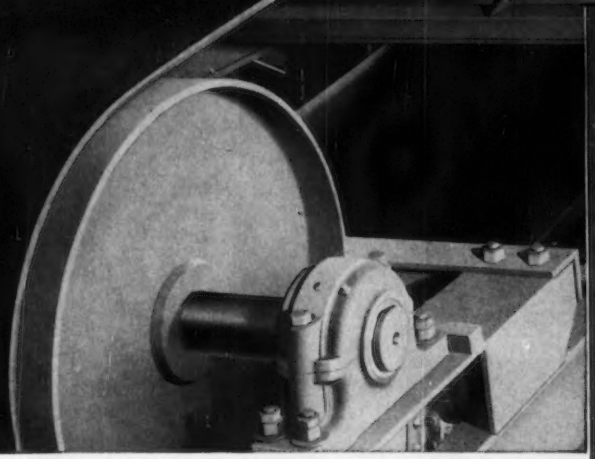

The Cable does not rotate!
McNally Pittsburg cradle idler design eliminates twists, harmonics–for only the rollers rotate.

That's why you get Greater Belt Life... Less Maintenance

McNally Pittsburg conveyor design adds big tonnage to your belts, cuts power costs, spares you many dollars in maintenance time and replacement parts. The secret of these savings lies in the patented cradle idler design. Big 5" rubber rollers are suspended in a true catenary, on flexible, stainless steel wire rope. They follow the belt contour, deliver deep troughing action, extend belt life and cut spillage.

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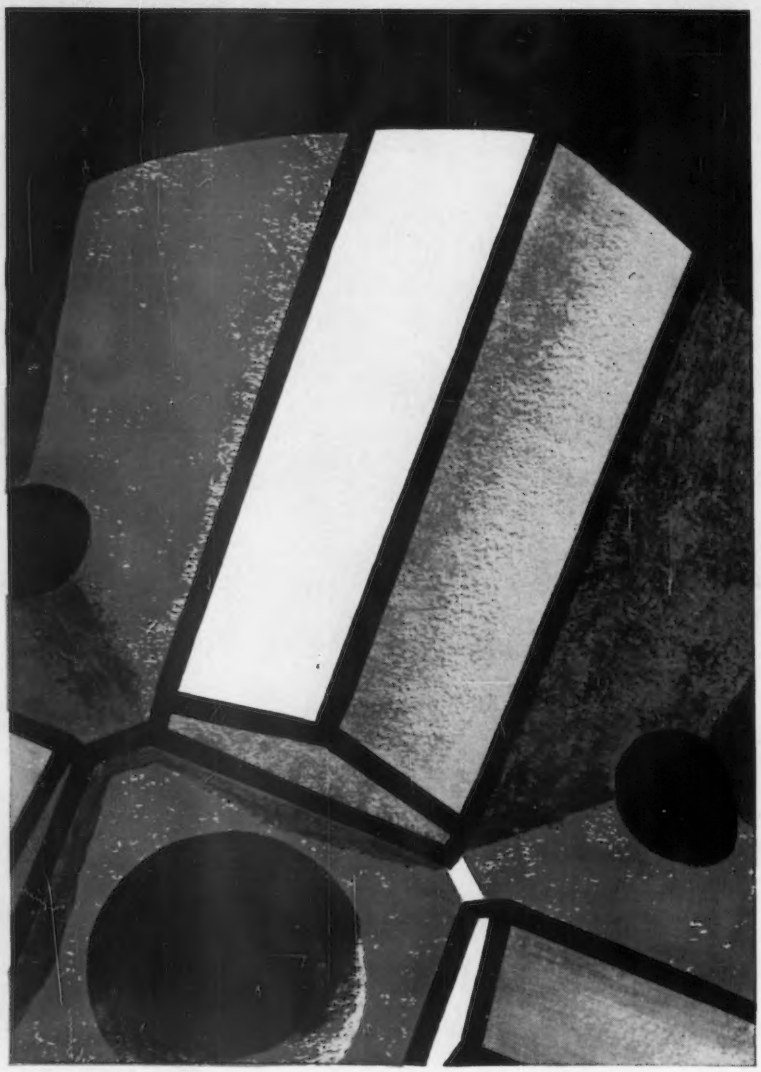
MORE HOLE PER-BIT



TO get lower cost per foot of hole drilled switch to the Timken® carbide insert bit—now improved to cut your drilling costs even more. One big improvement comes from our brazing process. It bonds the carbide inserts firmly to the bit body for greater shock-resistance. Inserts and bits last longer.

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More savings come from Timken bits' field-proven features. The 5 front hole design, pioneered by the Timken Company, directs air or water against the rock face, speeds chip removal. The deeper, wider wing clearance helps chips wash back faster.

With Timken bits you get on-the-job service, the kind you can't get anywhere else. Get full details about the complete line of Timken bits. Send for free brochure, "Timken Removable Rock Bits". The Timken Roller Bearing Company, Rock Bit Division, Canton 6, Ohio. Cable: "TIMROSCO". Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits.

TIMKEN®
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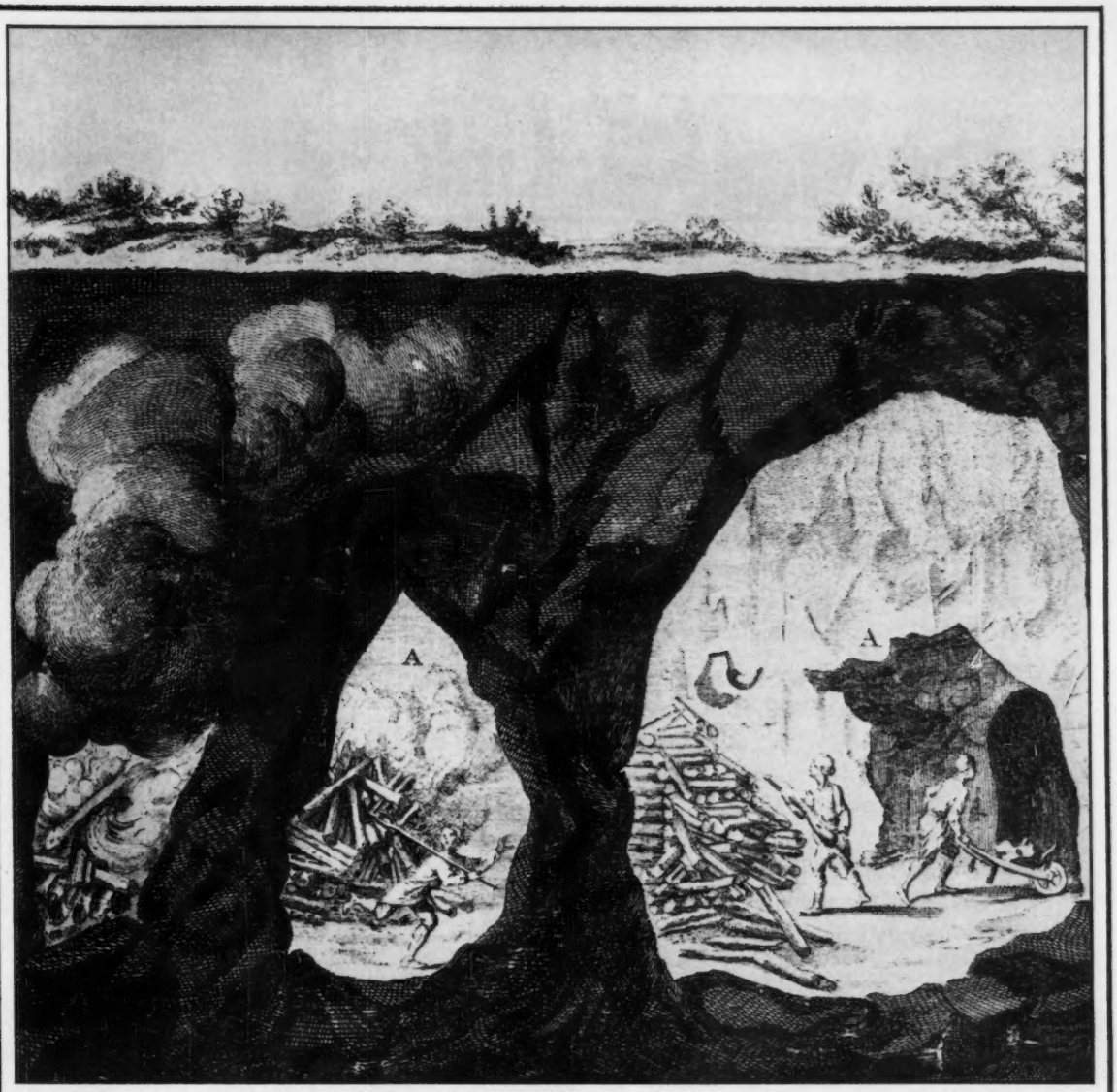
FOR OTHER TOUGH DRILLING JOBS

ALL-STEEL MULTI-USE
This improved Timken bit gives lowest cost per foot-of-hole in ordinary ground, when you can drill out full increments of steel.

TAPERED SOCKET BIT
Has same money-saving features as threaded bit. Secure union gives strength of one-piece steels.



Vol. VI, Mineralogie, 7me Collection, Pl.II.

Plate 132 Mining VI

Miners were torn between the temptation to ease their work, by blasting, for example, and the risk of doing so. Sometimes they would build a subterranean bonfire at the end of a gallery in hope that the heat would loosen the rocks—but not too much.

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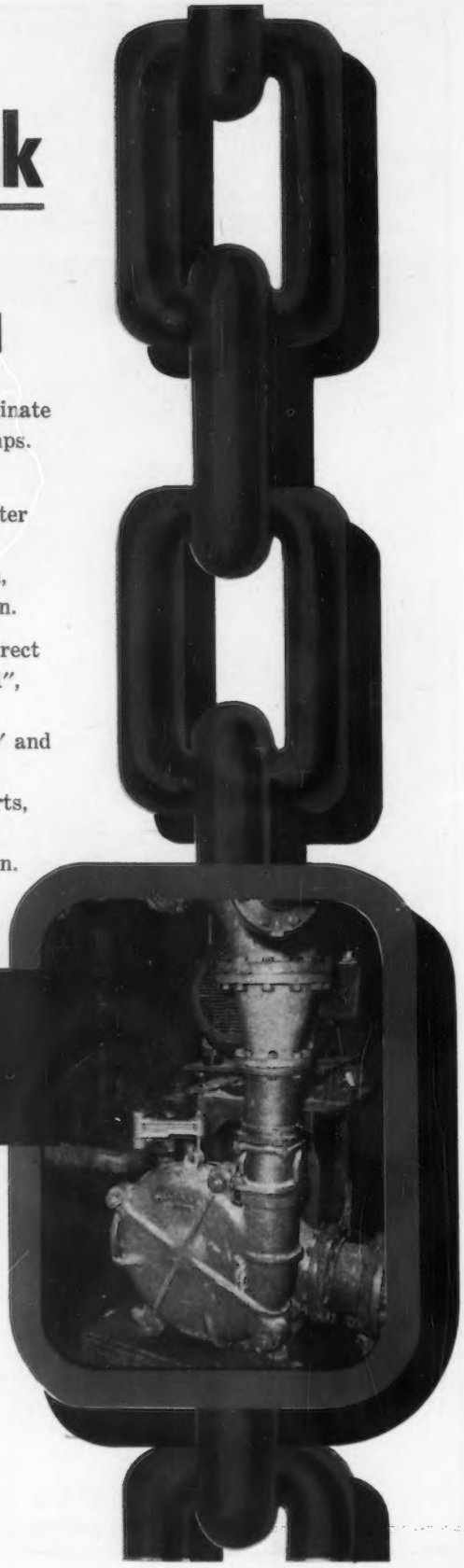

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Wilfley Acid Pumps

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50 Years of Flotation . . . Its Men, Ideas and Machines

THE FIFTIETH ANNIVERSARY OF FROTH FLOTATION IN THE U.S. will probably be one of the most thoroughly documented commemorative events in the field of minerals beneficiation. Two volumes, one a 600-page report by the Colorado School of Mines including papers presented at the Denver commemorative meeting at the AIME in September, and the other a comprehensive volume of "The 50th Anniversary of Froth Flotation," to be published soon by the AIME, wrap up virtually all technical, historical and economic aspects of the subject.

How Breakthroughs Begin

E&MJ's salute to flotation makes no attempt to duplicate this industry documentation, but rather to stress the great contribution which the men of flotation have made to mining and industry. A review of the evolution of flotation from the pages of E&MJ in 1911 to date, plus ideas contributed in this issue by numerous men active in the field of flotation clearly indicate that flotation owes its progress to men, ideas, and machines and reagents —in that order.

If flotation is to experience the technical breakthroughs forecast in the blue-sky sections of this article, such progress will be accelerated by staffing mineral processing projects with well-trained imaginative engineers, and encouraging them to develop completely new and unorthodox approaches to research problems confronting the industry.

In this salute to the men of flotation, we have listed names that have appeared repeatedly in articles and literature on the subject, numerous millmen, educators, inventors, sales engineers for reagent and equipment manufacturers, and others who have participated in the advance of the art in one way or another.

The lists of names included in this salute and the photos of the men presented are not intended to be a complete Who's Who of flotation, but rather a cross-section of the many men who have advanced the art over the years.

This 50-year perspective of flotation raises a most provocative thought —Did patents really stimulate progress, or by rewarding a few under the umbrella of ramified laws, was an entire industry set back 15 years or more?

The Case of The Modest Pioneer

A number of years ago while traveling through South America, I visited a little copper-gold plant located on an oasis in the Atacama Desert. This plant was treating about 100 tons of ore per day using both flotation and cyanidation. At the end of a long journey, I was asked to spend the night with an elderly gentleman and his wife. I was new to the territory and to the people so the name of my host Bobby Burns was just another name.

As a new engineer on the job, I took it upon myself to entertain my hosts with an after dinner discussion of the art of flotation complete with its history, advances and benefits. I had a very willing and attentive audience and as the evening progressed, I relaxed enough for a friendly discussion of my dissertation. I was given quite a shock because Bobby, in his quiet, reserved manner told me that my history of flotation was almost correct but that I erred in stating that the birthplace of flotation was a western mining camp in the United States

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Crocker

Cadwell

with the traditional assayers wife as its mother, because it really was in a London laboratory where the basic work on flotation was done and that at the same time there had been a pilot plant. Piloting in London was followed by the first commercial flotation operation in Broken Hills, Australia. I didn't really believe it nor could I refute it, but a short time afterwards I chanced upon a copy of Hoover's book on flotation and in the acknowledgment I found that Alfred K. Burns was mentioned as one of the men who operated the first pilot plant in London and started the first commercial operation in Broken Hills. Bobby later confessed to me that he was the same Alfred K. Burns. Our acquaintance grew over the years and during the following ten years I met Bobby in a number of small plants. Bobby, I later found, was responsible for a good many firsts in the field of flotation, although his modesty prevented him from telling it and I do know that he established the first flotation plant using sea water on copper minerals. This was for the Tocopilla Mining Co. in Chile, whose plant, which is in operation today, still uses sea water.

He was one of the first, if not the first, to float the basic copper sulphate minerals such as antlerite, chalcanthite and brocantite. I thought all along that I had been the first in 1945 but his records showed that he had been as successful as I, but at least twenty years before.

When Bobby could no longer hold up his end in the operations, he came into my laboratory in Santiago, Chile and insisted on giving me a hand just to keep in touch with flotation—although many times I felt that the advances we had made in the last 45 years were scarcely equal to those advances that he must have seen in those first few years of froth flotation.

E. P. Cadwell

Steps to Flotation Progress

Important steps in the evolution of flotation are listed in the accompanying table by Gaudin.

Other important developments suggested in letters from men prominent in the flotation field today are as follows:

"W. H. Coghill, F. D. DeVaney, U. B. Clemmer and S. R. B. Cooke—for pioneering in froth flotation of Carlsbad potash ores. See USBM Report of Investigations No. 3271, Feb. 1935."

"Numerous fundamental studies on many facets of the flotation process by Dr. Cooke."

"The double flotation process (anionic-cationic) now used in the Florida phosphate field, pioneered by Arthur Crago."

"Work of Taggart, Gaudin and Arbiter in education and fundamental studies of flotation."

"Walter E. Keck was the original discoverer of the value of petroleum sulfonate flotation agents. From his work, American Cyanamid developed the 800 Series of flotation reagents."

"Charles H. Breerwood pioneered the application of flotation to the manufacture of cement."

"James A. Barr, Sr. pioneered in the design of flotation cells for use in nonmetallic flotation. He was the first to recognize the importance of low-speed large-diameter impellers for agitation and aeration of soft minerals."

"Inventors of the Denver Sub-A, Fagergren, Galigher, Booth, Callow, Forrester and MacIntosh cells."

"The work of A. J. Weinig in the separation of potassium and sodium chlorides in saturated solutions is notable. Also his work in collaboration with R. E. Cuthbertson in the development of molybdenite flotation at Climax is worthy of mention."

"A notable first was the successful flotation of copper carbonates at Kennecott, Alaska in the 20's."

"Max Kraut, who developed the Kraut flotation machine used in the early 1930's for gold ores."

"Dr. Wm. Hirschkind, for development of the continuous process for manufacturing Great Western Xanthates."

"Lyle Barker, Ed. Engleman and Cooper Green for excellent work on copper flotation."

"To John M. Hyde, who first successfully demonstrated the economics of flotation process in America at Basin, Montana, under auspices of Butte and Superior Mining Co. in 1912."

"When litigation proved that the Sulman-Pickard patents were basically correct, and the use of less than 20 lb of oil was prohibited to any but licensees of Minerals Separation, it was E. W. Engleman in 1918 who developed a technique for using more than 20 lb of oil, and this development was used at Ray, Ariz."

"D. L. Forrester, 1924, who developed the air lift type of machine thus avoiding liming up the cells and the use of canvas bottoms."

"The Janneys at Utah Copper, Keller with M. S. Co., Whitworth with his aerofloat all evolved better reagents for use in the flotation process."

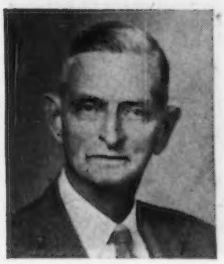
"The classic volumes published by Prof. Richards in 1909 confirmed the importance of the work of the early investigators and developed in detail the area where a breakthrough in ore dressing would have to occur. His quantitative data showed the serious difficulties inherent in the gravity concentration method for treating fine mineral particles, and the utter hopelessness as the sizes approached colloids. He provided the basic principles which led to the recognition of ore dressing as a technology rather than a trade. His principles became the building blocks of froth flotation."[1]

"A milestone in flotation history was reached in 1912, when F. J. Lyster at Broken Hill introduced the first selective flotation process which

LEWIS • LI • LINDROOS • LITTLEFORD • LOCKE • LOCKWOOD • LOGUE • LOWREY • LOWRY • LUNDROOS • LYLE • LYONS • LYSTER
McBRIDE • McDERMOTT • McDONALD • McGLASHAN • McGUIRE • McKEAN • McKINLEY • McLACHLAN • McNAUGHTON • McNEILL

Usoni

Allen



Van Smith

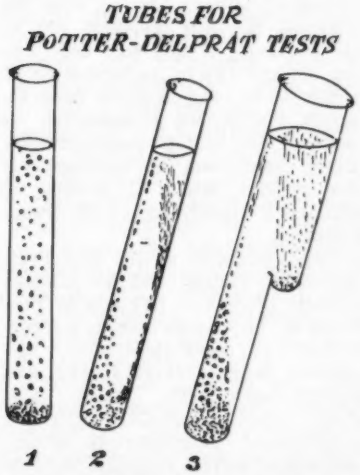
Weiss

Michaelson

Important Steps in the Evolution of Flotation[1]

Approximate date	Contributor	Contribution
1491	Mansur	Use of differences in wettability of minerals by oils and water to beneficiate ultra-marine and/or azurite
1731	Petit	Air-solid adhesion useful to buoy submerged solids
1860	Haynes	Bulk-oil process
1877	Bessel	Boiling process for graphite
1885	Bessel	Chemical-generation gas process for graphite
1886	Everson	Acidulated pulps desirable
1902	Froment, Potter, and Delprat	Gas as a buoyant medium for sulfide ores
1905	Schwarz	Sodium sulfide to recover oxidized base-metal minerals
1906	Sulman, Pickard and Ballot	Reduced amount of oil; introduction of gas by violent agitation
1909	Greenway, Sulman and Higgins	Soluble frothing agents
1913	Bradford	Sulfur dioxide to depress sphalerite
1913	Bradford	Copper sulfate as activator for sphalerite
1921	Perkins and Sayre	Specific organic collectors
1921	.....	Alkaline circuits
1922	Sheridan and Griswold	Cyanides to depress sphalerite and pyrite
1924	Sulman and Edser	Soaps for flotation of oxides
1925	Keller	Xanthates as collectors
1929	Gaudin	pH control
1929	Jeanprost	Flotation of highly soluble salines
1933	Nessler	Flotation separation of water-soluble chemical salt mixtures
1934	Chapman and Littleford	Agglomeration
1934	.....	Alkyl sulfates as collectors
1935	.....	Cationic collectors

[1]"Flotation," by Gaudin. Second Edition, Published by McGraw-Hill Book Co. 1957.



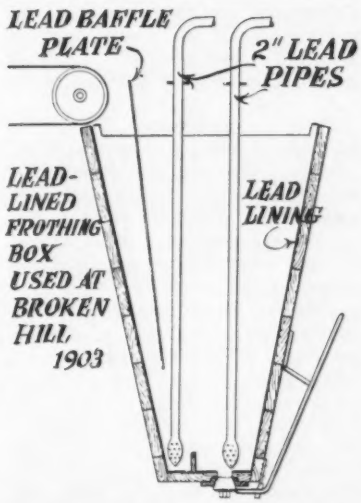
CALCITE, fine ore and acid were heated in early test tubes. Generated bubbles floated particles to top. Note trap for concentrates at right. After T. J. Hoover.[3]

permitted the separation of one sulphide mineral from another. This development was almost as important as the discovery of bulk froth flotation."[1]

"In the early 20's American Cyanamid Co. entered the field of flotation reagents. This company took over the patents of Frank Whitworth who developed the Aeroaflat type reagents and perfected their use at Utah Copper Co.'s mills. Cyanamid played a major role in the creation of a wide range of other reagents and in the development of the Fagergren flotation machine."[1]

1 Quotations from commemorative address on flotation by F. R. Milliken, Denver, Sept. 1961.

3 Drawings reproduced with permission from Colorado School of Mines Quarterly, "Fiftieth Anniversary of Froth Flotation in the U.S.A., A.I.M.M. & P.E.," July 1961. Illustrations appeared in chapter, "Flotation's Early Years," by E. J. Pryor, University of London, England, pp 217-239. See also list of selected references at end of article.



FROTHING BOX was used in Potter-Delprat process to produce dense froth. CO_2 was generated by action of hot acid on carbonates in ore. After T. J. Hoover.[3]

McQUISTON • McROBERTS • MacDONALD • MacFADDEN • MacINTOSH • MACQUISTEN • MALECZEK • MALOZEMOFF • MANCUSO
MARSHALL • MARSTON • MARTIN • MARULLO • MASOBELLO • MATALON • MATHEWS • MAWBY • MAYER • MELOY • MERRILL

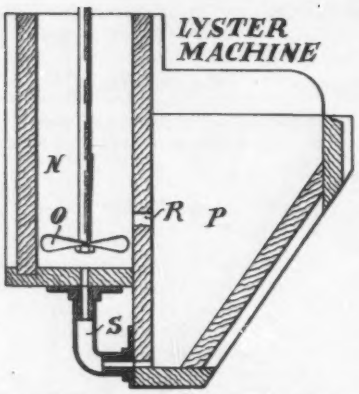
Zeigler

Bloecher

Counselman

McNaughton

Agers



LYSTER MACHINE consisted of mixing cell, N, and spitz-box, B. Cell was charged with water, acid, oil and 500 g ore sample. After T. J. Hoover.[3]

Observations of a Pioneer

A. W. Fahrenwald, inventor of the Fahrenwald flotation machine and well-known for his contributions to the field contributes the following profile of progress in flotation in the U.S.:

"It is my recollection* that the old Butte and Superior Copper Co., Butte, Montana, was one of the very first milling operations in this country to employ the flotation process. The process, however, was "oil flotation" and not froth flotation—pounds and pounds of oil were used. The froth concentrate was an oily mess—mostly oil. Ore minerals were galena and sphalerite. Flotation products were a tailing and a lead concentrate carrying a high percentage of unwanted sphalerite. The flotation machines were the early type of M.S. cells employing plus-sign (+) type impeller. There were two banks of these M.S. cells in the mill. One bank was equipped with bronze impellers—the other with iron. It was noted from day-to-day that the concentrates from the bronze-impeller cells ran higher in zinc than the concentrates from the iron-impeller cells. This situation naturally aroused speculation on part of management and laboratory personnel as to "how come."

"The M. S. Laboratory cell also was equipped with a bronze impeller. It was noted, too, that the laboratory cell made concentrates similar in grade to the bronze-impeller mill cells, but higher in zinc than the iron-impeller mill cells. Following logical thinking, the laboratory cell bronze impeller was replaced with an iron impeller. The laboratory cell, now with the iron impeller, gave results that were in line with the iron equipped mill cells.

"Continuing with the analysis, and suspecting, that possibly copper ions were "the nigger in the woodpile," copper sulphate was added in a new line of tests with the iron equipped lab cell. Result: the concentrate now carried more zinc than either bank of plant cells. The answer: copper ion is an activator of sphalerite.

"This, I believe, was the discovery of copper ion as an activator of sphalerite flotation—and incidentally, perhaps the first suspicion that much or some of the mechanism of flotation was purely chemical. There was, however, at this time, no scientific explanation for the effect of copper ion on sphalerite flotation.

"Almost at the same time, at the Timber Butte Mill, east of the city of Butte (a Clark property), two men, whose names are part of the history of the development of the flotation process, were conducting a research dealing with the depression and activation of sphalerite. These two men were Sheridan and Griswold.

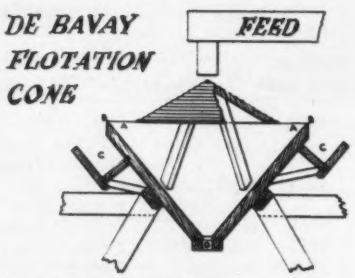
"Their research led to the development of the so-called cyanide (Sheridan-Griswold) process, (U.S. Pat. 142735) of depressing sphalerite in lead-zinc ore flotation—standard over these many years. Sheridan and Griswold, however, to my knowledge, did not offer the chemical explanation by which their result was achieved.

"A few years later, in one of the finest pieces of flotation research on record, A. M. Gaudin, at the Butte School of Mines, came up with the chemical reactions involved: (1) in the activation of sphalerite with copper ion and (2) in the depression of sphalerite by cyanide. Other early research that helped tremendously in understanding and developing the scientific mechanism of flotation was that of Prof. Wilder D. Harkins of Chicago University and of Dr. Irving Langmuir.

"The Research of the late Prof. Arthur F. Taggart and his students (Trans. 1923, Vol. 68) and of Professor A. M. Gaudin and his students and my own work (MINING AND SCIENTIFIC PRESS 1921, Vol. 123, and MINING AND MET. JOUR. 1924, AIME Trans. Vol. LXX, 647, 1924) contributed significantly to understanding of surface reactions, variable surface tension, etc., in froth flotation.

"One outstanding study made in the field of reagents is, I feel, the con-

* Fresh out of South Dakota School of Mines, I was employed at the plant in 1915.



DE BAVAY METHOD, later was taken over by M.S., used flotation cone to overflow sulphides at launder, C, and underflow tails at D. After T. J. Hoover.[3]

MICHAELSON • MICHELL • MILLER • MILLIKEN • MILLS • MITCHELL • MOIR • MORPHETT • MORRIS • MORROW • MORTENSON
MOSES • MOUNTJOY • MUNRO • MYERS • NEUHAUS • NEUNHOEFFER • NEVETT • NIXON • NOKES • NORMAN • NOTEVORP

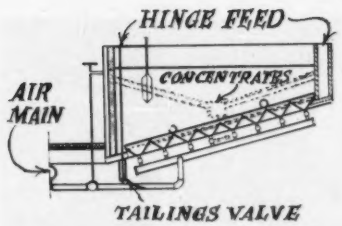
Diamond

McGlashan

Bhappu

Gaudin

Hernlund



CALLOW FLOTATION APPARATUS

THE CALLOW flotation machine was called a "supra-aeration" machine. Low pressure air was blown in through porous mat at bottom. After W. Broadbridge.[3]

tribution of Sheridan and Griswold and the contribution of Gaudin in supplying the chemical answer to their discovery.

"The discovery of xanthate in 1922-23 (Keller) as a collector was, I should think, the next major forward stride in reagents. This discovery put flotation, at least in my opinion, on a realistic chemical basis. It was a reagent of known composition and molecular characteristics (polar/nonpolar) and its rection at a mineral-water surface could be written down. It also was the signal that there could be many other reagents of similar composition and usefulness flotation-wise. Many others have been discovered.

"Then there came so-called soap flotation (fatty and resin acids and their alkali salts) reagents, which by themselves, or aided by an activator (usually a salt of a bivalent ion) gave flotation to a whole host of non-sulfide minerals (Sulman and Edser, 1924).

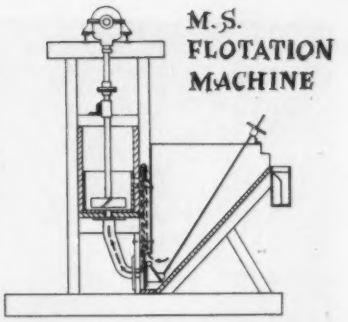
"In 1923-24 hydrogen ion, (pH) entered the reagent picture (Fahrenwald, AIME Trans. Vol. LXX, 647, 24, also see, Professor Locke, MINERAL INDUSTRY, Vol. 1924), as a modifying and controlling factor in the use of collectors. Most, if not all, flotation mills now operate at specific pH levels—many employ automatic control systems.

"One of the first flotation machines, many of us can well remember, was the M.S. machine. First the machine which produced aeration by creating a vortex above the impeller and around the drive spindle, and then later the sub-aeration machine. Not a bad machine, but inefficient as to power per unit of ore treated. The first M.S. machines were gear driven with all the bad features of the gear drive. There are still some of these machines in use.

"There were tried along the line, so-called deep (large volume) cells. These were sponsored by operators who thought the capacity of a flotation machine was in direct relation to volume of the cell, which is not necessarily true ("Flotation as a Power Process", E. H. Rose, MIN. TECH. Mar. 1944, T. P. 1702).

"Other machines depending purely upon mechanical treatment (agitation) of the pulp to produce aeration, were the Kraut (both vertical and horizontal rotor) machines; the Fagergren machine and the Denver Sub. A. (Fahrenwald). The Fahrenwald machine was the first (1923) to employ the gravity flow principle of pulp circulation both (within the cell unit and from cell-to-cell) which made it especially suitable for: (1) using banks of cells in series, (2) treating coarse sand pulp and (3) making a finished (cleaned) concentrate in a simple closed circuit operation. It was also the first machine to employ the multiple horizontal V-belt drive, soon thereafter to be adapted to all makes of vertical spindle machines.

"Other early forms of flotation equipment were the Callow pneumatic cell in which aeration of the pulp was effected by forcing air through a canvas stretched over a sloping-bottomed rectangular cell, and the MacIntosh



BASIC FLOTATION CELL designed by T. J. Hoover was first developed commercially as a stepped-down series of boxes. After W. Broadbridge.[3]

which employed a rotating canvas covered drum. And then there was a variety of air-lift type cells and cascade machines.

"All but about three machines have fallen by the wayside. Some of the reasons for their demise are: (1) insufficient intensity of agitation (working of the pulp), (2) operational difficulties such as sanding-up, (3) difficulty of setting up roughing and cleaning operation in a simple closed circuit and (4) costly up-keep.

"The surviving machines (Fahrenwald, Fagergren and Agitair) are vertical spindle machines driving an impeller at the bottom of a substantially rectangular cell. Two of these make their own air, and the other (Agitair) requires a blower.

"It took many years for flotation engineers and operators to recognize the importance of doing work on the pulp (conditioning by mechanical agitation) before subjecting to bubble treatment (aeration). A good recent example of the importance and need of conditioning was the operation at Manganese Inc., Henderson, Nevada (Emulsion Flotation, A. W. Fahrenwald, MINING CONGRESS JOURNAL, August 1957).

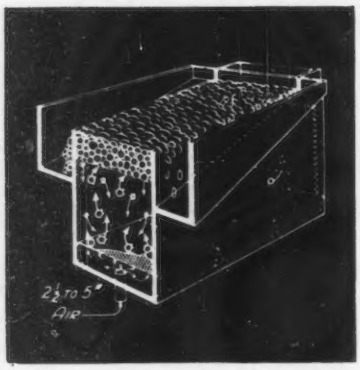
Rose

Arbiter

Roe

Fraser

McQuiston



PNEUMATIC MACHINE with porous canvas bottom. Air pressure ranged from 2½ to 5 lb. Concentrates were squeezed or pushed over the sides into launder.[2]

How Flotation Got Its Start

Van H. Smith, mineral dressing consultant of Toronto, Ontario, has prepared the following account of his association with the pioneers of flotation in the U.S. and Canada, and a detailed description of early test methods used by millmen who were responsible for introducing flotation into the gravity mills of yesteryear.

My introduction into ore dressing and flotation work was at the mill of the Butte and Superior Mining Co., Butte, Montana, in the early part of 1914. The staff there consisted of J. L. Bruce, manager; E. Wickes, mill superintendent; J. T. Shimmin, assistant mill superintendent; B. W. Dosenbach, metallurgist; J. F. Myers, flotation experimental metallurgist; J. V. Quigley, flotation experimental work.

It was these men who established flotation at the Butte and Superior, after having had the process pioneered in Max Atwater's plant at Basin, Montana by James Hyde.

The ore being treated was a complex one, principally zinc, but with good values in lead, silver and of course some pyrite. The flow sheet was of the usual gravity concentration type using tables and jigs with the necessary auxilliary equipment of classifiers and screens.

Reground gravity concentration tailings plus slimes from such concentration, made up the feed to the flotation circuit.

Originally, the Butte and Superior plant had been gravity concentration only, but interest was aroused by the announcement of the establishment of a pilot flotation plant and research laboratory in England to demonstrate the efficacy of the process then patented by Sulman and Picard and assigned to Minerals Separation Co., Ltd. Arrangements were made to ship a carload of Butte ore to England for such testing. After six or eight months, the word came back to Butte that the Butte & Superior ore was not amenable to treatment by their process.

About six months later Hyde came out to Butte and explained that he had worked on this ore at the English laboratory and test plant and that he was convinced that flotation could be used economically, and requested that the Butte and Superior Co. finance a pilot plant where he could carry out his ideas. Since the original mill of Butte and Superior had been at Basin, Montana, this was where the pilot plant was established and where the ideas of Hyde were successfully demonstrated.

Arrangments were then made to build the main mill adjacent to the mine at Butte, such mill to include flotation.

The cells used were just simple agitators in square boxes, pulp being transferred from cell to cell by means of vertical pot pumps.

The circuit consisted of roughers, cleaners, and recleaners.

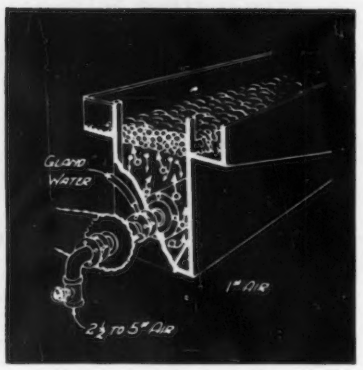
Flotation feed assayed from 16 to 20% zinc, final flotation concentrates 49 to 50% zinc, and tailings 2.5 to 4.0% zinc.

Reagents, sulphuric acid about 4 to 6 lb per ton, oleic acid and some pine oil were used.

Of course the gravity section of the mill recovered about 30 to 35% of the total zinc ore as a gravity concentrate 51-52% zinc. Concentrates were shipped to American Metals Co. in the middle east. Zinc at that time was 4.25 to 4.65¢ per lb. American Metals Co. took 10,000 tons zinc concentrate per month, settling on the E&MJ price.

Tonnage milled by Butte and Superior was 500 to 700 tpd, later 1900 tpd.

[2] Drawings in reverse are reproduced from "Results in Modern Flotation" Published by Denver Equipment Co. in 1929.



PNEUMATIC MACHINE with air introduced through rotating drum covered with porous blanket. Air was introduced at 2½ to 5 lb.[2]

Testing Ores for Flotation —1913-1920

Samples of ore were ground dry, rolled thoroughly and used in 300- to 500-gram lots in individual flotation tests.

The test cell employed was made of bronze, the impeller shaft passing through a stuffing box in the center of

PROSSER • PRYOR • QUIGLEY • RABONE • RAFFINOT • RALSTON • RAMSEY • RAVITZ • RAY • READ • RECK • REITER • REY
RICE • RICHARDS • RICHARDSON • RICKARD • RICKETTS • RIDEAL • RIETZ • RIZO-PATRON • ROBSON • RODOZ • ROE • ROGERS

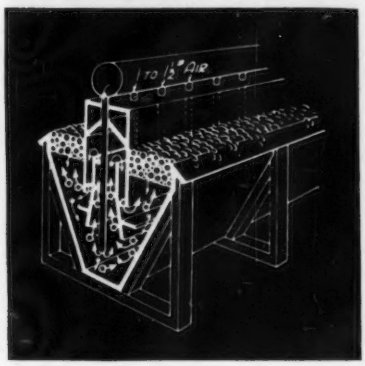
Milliken

Thom

Lewis

Stephenson

Reck



TROUGH-LIKE pneumatic machine with air introduced in center through series of free pipe openings. Air was introduced at 1 to 1.5 lb pressure.[2]

the bottom of the cell. The cell itself was divided into two halves or clamps. The ore-water ratio employed during the testing was 1 to 4. Hot water was employed, and usually about 6.0 lb sulphuric acid per ton of ore.

Oil and frother were added and the mixture conditioned for three minutes. Then agitation was stopped. The froth rose to the surface, the pulp settled to clear water and the froth was removed by means of a sliding arrangement.

With the slide back in place and the two halves of cell clamped together, hot water was again added to original level in the cell, and agitation continued for one minute, when again the impeller was stopped, pulp allowed to settle and the froth skimmed. This procedure was usually continued for 6 to 10 such cycles of agitation and froth removal.

Then tailings were drained from machine and the froths combined as desired. All products were then dried, weighed and assayed.

One now realizes that heat, sulphuric acid, abrasion, all tended to attack the copper in the metal of the test machine and form small quantities of copper sulphate, while such testing was going on. Also, in the Butte and Superior ore, there was copper sulphide, all adding to the production of such copper sulphate while testing was under way.

Early Growth of Flotation

World War I caused an unprecedented demand for metals.

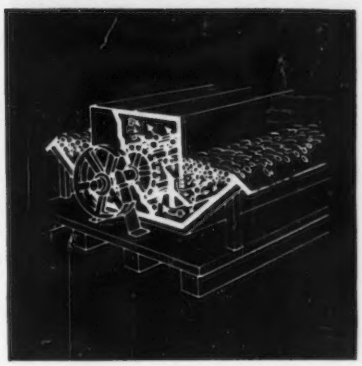
Most concentrators treating ores at that time recovered only 50 to 55% of the contained mineral on the jig, Vanner, table, or canvas table equipment. Losses were in the minus 150-mesh sizes. Flotation was the coming tool by which these slimes could be recovered. By installing flotation equipment, most plants were able to increase their mineral output from 55% up to 85%—with no additional ore required, just a few operators on each shaft. Thus this extra demand for minerals was supplied.

Concentrators still retained jigs, tables, etc., and such equipment required much floor space and considerable manpower.

In 1916 I was called upon to go from Butte to Canada to erect a pilot plant on the treatment of a copper ore. Gravity machinery and methods only recovered 28% of the copper in this ore (now Granby Co.-Allenby & Copper Mt., B.C.). Flotation recovered 83 to 85% of the mineral. Our staff and consultants decided to erect a 2000 tpd plant—employing flotation only.

During construction, money ran short, so Mr. Jackling sent Louis Cates and Doug Moffatt up to B.C. to report, and they reported so favorably, that Hayden-Stone put up the remaining money necessary.

We discussed the simplicity of the Allenby flowsheet, the floor space, operators required, and Messrs. Cates and Moffatt were sufficiently impressed to authorize a 1000-ton section at the Arthur plant of the Utah Copper Co. to be converted to an "all-flotation" flowsheet (1919).



LONG AGITATING CHAMBER in which perforated drum rotates and mixes pulp and air. Long trough spitzkasten installed on front and also on rear if desired.[2]

Within three months, the conversion of the entire plant was authorized. Since that date, most major concentrators have employed an all-flotation circuit.

Thus I feel that my own work in Canada has contributed to the advancement of the technique of ore treatment.

In 1916, R. W. Diamond who had pioneered the flotation work for the Anaconda Co., was called to Canada also—to Trail, B.C. to develop a process to treat the complex ore from Kimberley mine for Consolidated Mining & Smelting Co. His success on that operation is well known throughout the world. He and S. G. Blaylock authorized signing of agreement with Sheridan and Griswold for the use of their cyanide patents in treatment of complex ore. Construction on the big plant at Kimberley was started in the early 1920's.

(See also reference to historical paper by Diamond at end of article.)

RORK • ROSE • ROUSE • RUGGLES • RUNKLE • RUTH • SACK • SALTER • SAMUEL • SANNA • SASAKI • SAUNDERS • SCHNEIDER
SCHUBERT • SCHUHMANN • SCHULMAN • SCHULMANN • SCOTT • SEALE • SHAPLEY • SHELLSHEAR • SHELTON • SHERIDAN

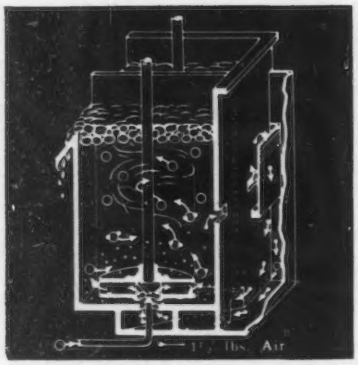
Ovitz

Taggart

Damon

DeVaney

Crabtree



MACHINE consists of a series of cells. Each cell is a unit agitating and separating chamber. Pulp is sucked up through narrow opening by closed impeller.[2]

Early Problems and Solutions

The following account of the early developments in the art of flotation in the Northwest was prepared for this anniversary article by W. L. Zeigler who was among the authors who contributed articles on the subject to E&MJ when the art was in its infancy.

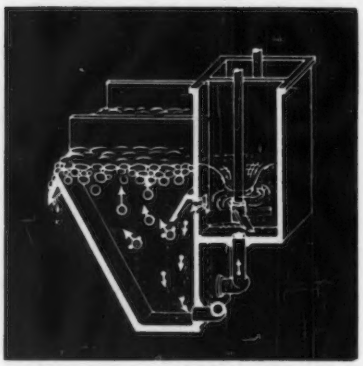
Flotation was first used on the fine tailings from tables and vanners in gravity concentration mills which were a natural for the process as they were already fine enough and usually higher in metallic content than any other tailings from the mills. On the other hand the fine tailings contained all the natural or primary slimes from the ore as well as a concentration of middlings from various steps of crushing and grinding in the gravity process. For this reason, as was proven later, the tailings were far more difficult to treat by flotation than when the process was used on the total ore.

As the use of flotation became more general, further grinding was done on middlings increasing the proportion of the ore going to the process. On many complex ores, however, gravity concentration preceded flotation in some stages for many years to come for the following reasons:

1. To avoid cost of grinding and flotation, take clean minerals, both concentrates and tailings, from the circuit.
2. Smelters were not yet equipped to handle the excess of slime concentrate. In some cases smelters paid a premium for coarse concentrates.
3. To reduce royalties to the owners of patents on flotation.
4. Closed circuit grinding, so necessary to flotation, with ball mills and classifiers was in the development stage and improved along with the greater use of flotation.
5. Reagents and the process as a whole were unreliable especially in complex ores. This made it impossible to depend on flotation alone.
6. With complex ores, particularly those containing lead and zinc, it was possible to make separate concentrates of each by jigs and tables used in gravity concentration. But only a combined concentrate could be made on the fines by flotation until years later after the discovery of collector and inhibitor reagents. Mechanical innovations were tried in the Coeur d'Alene mining district to float galena first and zinc minerals second. Some measure of success was obtained but results were not conclusive. ("Flotation of Coeur d'Alene Ores" by W. L. Zeigler. E&MJ 1916). Combined lead and zinc could not be treated economically in pyrometallurgical smelters. This fact stimulated development and installation of electrolytic zinc plants.

Advances in Flotation Reagents

The first reagents used in froth flotation were oleic and sulphuric acids. Bronze impellers used in the acid circuit were responsible for the accidental discovery of the use of copper sulphate so necessary for flotation of zinc sulphides. This discovery was never patented and was free to all users.



MACHINE consists of a series of cells. Each cell has agitation chamber in rear. Separation of froth and gangue takes place in spitzkasten.[2]

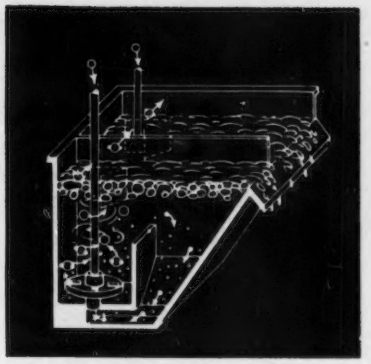
About 1912 Wark discovered the frothing qualities of eucalyptus oil in neutral pulp in Australia. This was the first important breakthrough in reagents. In this country, pine oil and wood creosotes came into use shortly thereafter. These were followed by heavier pine tar oils.

Coal tar derivatives such as Barretts No. 4 appeared about 1917 being used as a collector with pine oil for frothing.

In 1920 cresylic acid became prevalent as a frother showing greater selectivity than the wood oil products, also being useful in alkaline circuits where pyrite was present.

About this time Sheridan and Griswold perfected the use of cyanide and zinc sulphate in an alkaline circuit for selective flotation of lead, zinc and iron sulphides, which was a major breakthrough for flotation of ores of this character. Concurrently, aerofloats and xanthates became important as collectors for all types of

SHIMMIN • SIMPSON • SINGEWALD • SITIA • SMITH • SORENSON • SOUGSTAD • SPEDDEN • STEIN • STELLA • STENHAGEN
STEPHENSON • STEVENS • STEWART • STICKNEY • STRAGIOTTI • STREET • SULMAN • SUN • SUNDT • SUTHERLAND • SUTTON



AERATION PRODUCED by rotating impeller sucking pulp through narrow passage. Impeller draws air through hollow rotating shaft.[2]

ores and had the effect more or less of changing flotation from a mechanical to a chemical process.

Many men, working with flotation in the laboratories and concentrators, have been responsible for the development of the process. At first, because it was a crude process with almost unlimited possibilities for treatment of fines in ore concentration, much secrecy was prevalent among the users. This was amplified when Minerals Separation brought suit against Butte and Superior and Miami Copper Co. for infringement of patents. Both suits were decided in favor of the plaintiff which established their right to collect royalties for the life of the patents. For this reason operators were hesitant to publish details of their use, and especially their improvements of flotation, and were also wary of visitors in their plants. For this reason many who developed the process were unsung heroes.

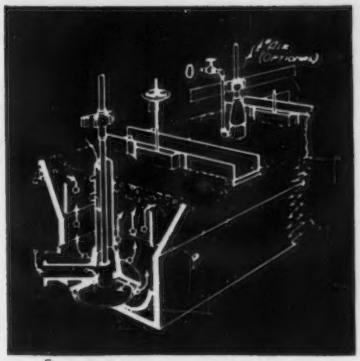
Looking back over fifty years of flotation it seems that most of what we had hoped for has come to pass. Certainly most of the low-grade, open-pit copper mines could not exist or have been developed without this process. Many of the large complex lead, zinc, copper, iron orebodies, unworkable before selective flotation, were placed into successful operation, the most notable being the Sullivan Mine of Cominco at Kimberley B.C. Molybdenum, so necessary for toughening steel could not have been produced in quantity by any other known method. It is possible to float mineral oxides and carbonates by sulphidizing with proper reagents as well as nonmetallic minerals.

Early Progress at Inspiration

Inspiration Copper Co. was one of the first major companies to study flotation as an economic method of concentrating copper ores at its operations in Arizona. Mr. C. G. Stuntz, assistant general manager of Inspiration Consolidated Copper Co., has prepared the following set of notes taken from early company reports outlining Inspiration's early work in this field.

1912. Report by C. E. Mills, general manager. Previous to consolidation (of Inspiration Copper Co. and Live Oak Development Co.) Inspiration Copper Co. had made a long and careful series of tests on the concentration of its ores under the direction of J. M. Callow. Results of these tests and of a flowsheet worked out by Mr. Callow promised good results. In December last the company arranged with Minerals Separation Co. to make a trial of its flotation process. A method was developed by which, in a mixture of one part by weight of finely crushed ore, and from two to three parts of water, the mineral constituents are separated and floated to the surface. The resulting froth is skimmed off. Such separation and flotation is accomplished by introduction into the pulp of a small quantity of certain oils accompanied by the aeration of the pulp by violent stirring previous to flotation. A machine of 50 tpd capacity has been sent to the mines, and tests are now being made, from the results of which will be determined whether or not this process will be adapted to the treatment of our ores.

1914. In January 1913 we began experimental running of our ore in a flotation unit of 50 tpd capacity and continued such work until the June following, with results that on the whole seemed favorable. During the latter part of the year we built a temporary crushing plant at the Scorpion shaft and an experimental flotation plant of 600 tpd capacity. This plant started on January 3 of this year and has been running since—fed with ore taken from development work of the mine. The concentrates have been cleaner of silica than we had expected from our experience in the smaller plant. The average results to date have been better than had been accomplished on similar ores by water concentration and the recoveries are improving.



DENVER SUB-A machine consists of series of cells each having a separate agitating and aerating zone with spitzkasten for froth separation and removal.[2]

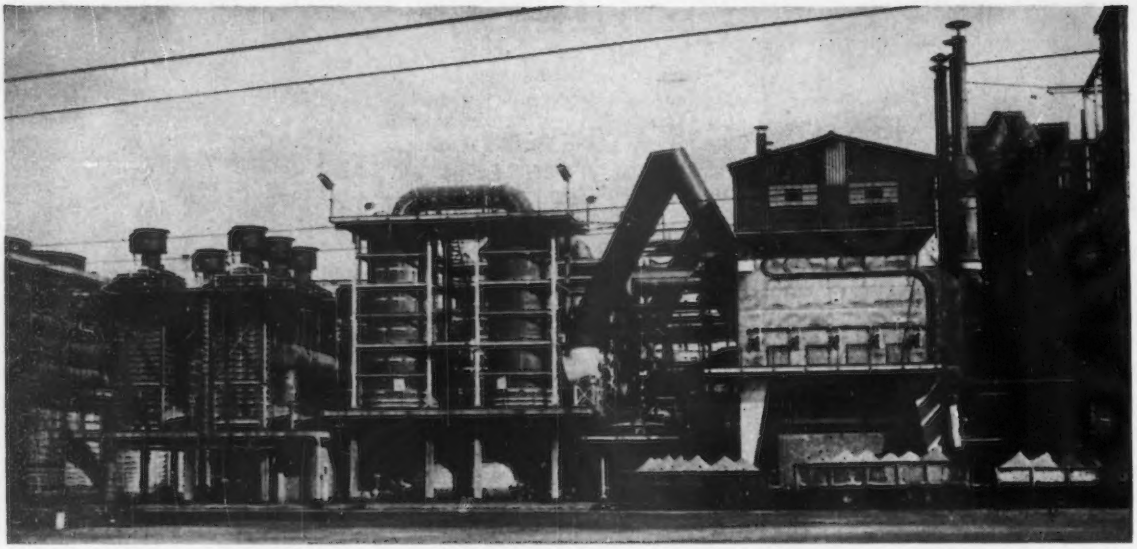
The idea of the larger test plant was to try out the process in units of such size as we propose to use later and to work out the minor details of the plant in time to incorporate them in the mill, which meanwhile is building along the general lines which our experiments indicated as best suited to the flotation process. Treatment will consist in part of ordinary table concentration and the design of the mill will allow it to be made wholly so with comparatively little expense should it ever be desirable.

1915. In the beginning a water concentrator of the regulation type was designed and structural steel for the mill building contracted for. Flotation experiments in the treatment of the ores subsequent to this contract, resulted so favorably that this steel order was suspended and finally cancelled. New details of treatment applicable to the new process were worked out, based on current experimental work, and a new start in mill design was made. As a consequence, it was not until early in the current year that much of the machinery in the grinding and flotation departments was ordered. The resultant combination flowsheet involving the practice of both flotation and wet concentration will show a material increase in the copper recovery from ores treated over either process when used alone.

At the time the original experimental unit was started, (January, 1913), no copper ore was being treated on a commercial scale by flotation in this country. The results from the 50 tpd flotation test unit first installed led to the adoption of the

(*Continued on p. 116*)

SWAINSON • TAGGART • TAYLOR • TERRY • THEYS • THOM • THOMAS • THOMPSON • THORNTON • TREWEEK • TRUSCOTT
TUCKER • TVETER • TYE • USONI • VAN SMITH • VARLEY • VASQUEZ-ROSAS • VINCENT • VOLIN • WADSWORTH • WAINWRIGHT • WALVOORD



THE BALEN INDUSTRIAL COMPLEX is one of the finest examples in Europe of the integration of an electrolytic zinc plant, a lead plant and a sulphuric acid plant, and of the various facilities for the recovery of valuable by-products.

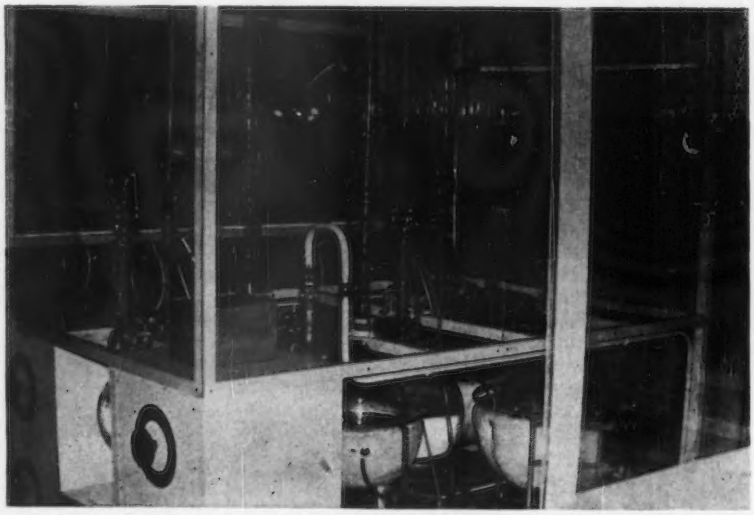
How Vieille-Montagne Integrates By-Product Recovery in Pb-Zn Plants

JIM MORRISON, McGraw-Hill
World News, Bonn, West Germany

SOCIETE ANONYME DES MINES ET FONDERIES DE ZINC DE LA VIEILLE-MONTANGE, in Angleur, Belgium, is presently the world's largest producer of zinc. At its major production plant near the sparsely-populated Balen on the Antwerp-Liege canal, company researchers have successfully devised a unique method by which the extraction of all the many metals occurring in zinc and lead blende has not only become technically feasible, but also economically profitable. Balen is an industrial complex covering all of 70 acres and is one of the finest examples in Europe of the integration of an electrolytic zinc plant, a lead plant and a sulphuric acid plant, and of the various facilities for the recovery of valuable by-products.

Balen Is 70 Years Old

At the beginning, seventy years ago, the Balen plant was built to roast the zinc blende ore needed by the other plants of the company where the zinc is produced by the "Belgian method" in horizontal-retort furnaces. The ores coming from all parts of the world were discharged in Antwerp, and from there, sent to Balen to be roasted: the roasted blende was then sent to the Liege facility to undergo the reduction process. The roasting of the zinc blende is a two-step process: pre-roasting in a Spirlet furnace followed by a dead-roasting on a Dwight Lloyd sintering band. After precipitating the dust carried by the roasting gases, which is rich in valuable metallic by-products, by a multiple-step dry-wet Cottrell process, the SO_2 contained in the gases is converted into sulphuric acid by the contact method. Originally, this sulphuric acid was used very extensively for the production of a superphosphate fertilizer, but nowadays a portion is used to prepare the



ABOUT 5 TPY mercury from wet Cottrell precipitator sludge is recovered by distillation in a muffle furnace and air-tight chambers. See p 98 for description.

electrolyte used for the production of refined 99.995 zinc from the zinc oxide left after the roasting process, and the remainder is sold.

In the Liege plants, the after-reduction residues are regarded as a kind of lead ore due to their containing about 10% lead, all the copper, iron, and silver contained in the original zinc blende. But these residues alone were not valuable enough to have made it worthwhile installing a special lead-recovery plant. What the company did do, however, was to devise a method, and install a plant at Balen, whereby the processing of the residues could be combined with the processing of the roasted lead sulphide ores.

By-Product Recovery Started

From this point on, the firm's scientists have concentrated their efforts chiefly on the recovery of the valuable by-products from the crude zinc and lead produced in the main smelting process, and from the various solid residues formed during the production process. The crude lead from the smelting plant still contains certain quantities of copper, antimony, tin, arsenic, silver, and gold, whereas the ferrocalcareous slags formed during the lead-ore smelting process are relatively rich in zinc, with smaller amounts of copper, tin and germanium. The crude lead is Harris-process refined in kettles in order to remove arsenic, tin and antimony. These elements are then recovered individually in the form of marketable compounds. The silver is recovered from the pre-refined lead in a Parkes de-silvering plant. The solid slags formed during the lead-smelting process were originally dumped, resulting over the years in dumps totalling several hundred-thousands of tons and containing, on the average, about 15% Zn, 2% Pb, 0.5% Cu, and traces of Ge. A fuming stage with Philipon hot-air blast furnaces involving the use of coke was originally devised by Balen engineers for the processing of this dumped material, but today the process is carried through using oxygen-enriched air. In addition to a valueless slag, the process produces a mixture rich in zinc and lead oxides, and a matter rich in copper and also containing some noble metals.

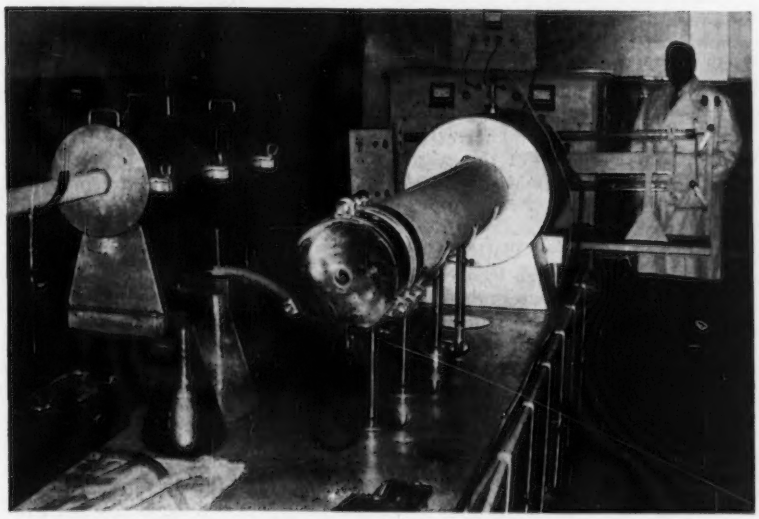
The roasted zinc ore produced by the roasting of zinc blende and the impure zinc oxide produced in the fuming process are directly converted into a high-grade, high-purity zinc by an electrolytic process. For this purpose, the two materials are first dissolved in sulphuric acid returned from the electrolyzing cells and made-up, as necessary, with fresh acid. The resulting zinc sulphate solution contains also an appreciable proportion of cadmium sulphate and traces of germanium sulphate. In addition, an insoluble sludge is formed containing lead, certain insoluble zinc compounds, copper and also further traces of germanium. From the sulphate solution, the cadmium, together with part of the germanium, is precipitated by a treatment with zinc dust. The purified solution is then subjected to electrolysis for the recovery of pure zinc. The electric power required for the process is supplied by a company-owned power plant, the boilers of which are fired with coal plus combustible gases produced during the fuming process, and also use the sensible heat of the roast gases. Both the cadmium precipitate and the residue insoluble in sulphuric acid are processed to recover all the valuable metals they contain.

Germanium Caused Problems

Germanium, a valuable semi-conductor material, is present in very small quantities in the zinc ores. Apart from the value of germanium as a metal, an additional ground for its recovery in the Balen works was the fact that the presence of increasing amounts of germanium in the zinc-cell electrolyte led to a progressive reduction of the power yield of the cells which might, ultimately, cause the entire electrolytic process to become uneconomical. This did occur once in the plant history when germanium was allowed to remain in the cyclic production process without ever being extracted. Balen researchers and scientists devised a method of extracting the germanium in that it is now removed in the form of its tetrachloride from the insoluble residue obtained in the preparation of the zinc sulphate electrolyte, since it was found that germanium accumulates mainly in this residue. After purification, the tetrachloride is subjected to hydrolyzation and the resulting germanium oxide is either sold or reduced to the germanium metal and sold as such. The processing of the vast amounts of residues containing germanium, i.e. those available in the Balen dumps together with the residue continually being produced during the normal plant operation, have made the Société Anonyme des Mines et Fonderies de Zinc de la Vieille-Montagne one of the largest producers of this metal in the world. It was the first germanium-producing company in Europe and second in the world.

The waste products of the closed-circuit process are further processed to recover other by-product metals such as cadmium, mercury, and thallium.

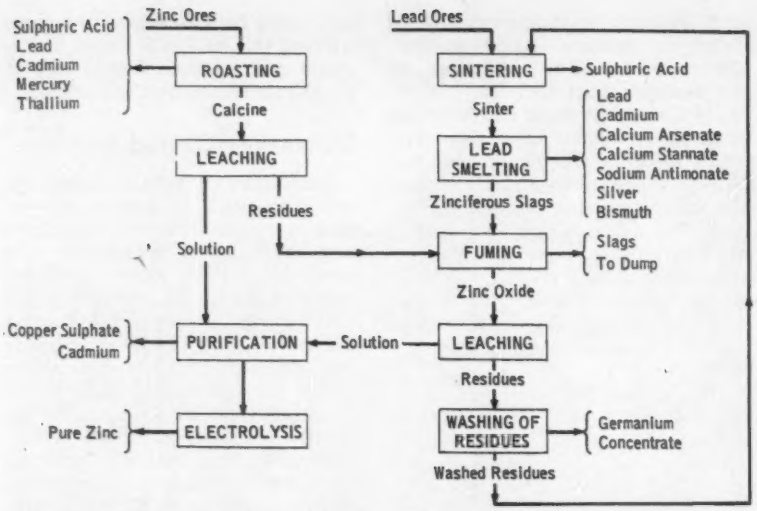
Presently, the company has an anual production in excess of 200,000 tons of zinc, 35,000 tons of lead, and about 300,000 tons of sulphuric acid at 60° Bé. (See flowsheet I.)



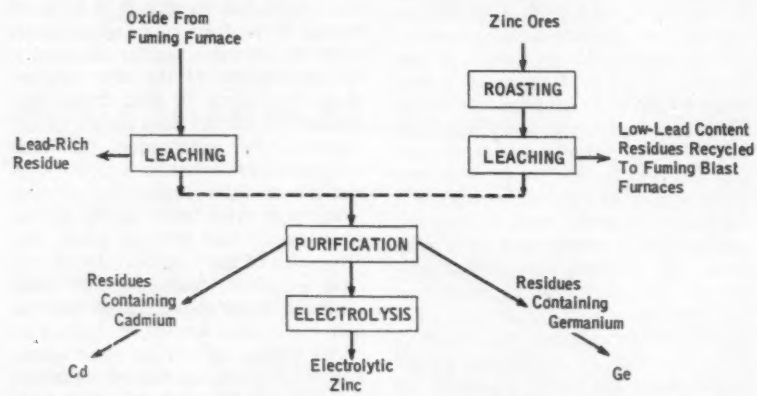
TWO-STAGE reduction of germanium dioxide is carried out in tabular furnaces at Balen. First stage temperature is 1220°F which is increased to 1830°F for second.

Zinc Electrolysis

The zinc oxide initially produced in the sublimation or fuming process was sufficient to yield 20 tpd zinc but, as home and foreign demands for a high-grade zinc increased, Vieille-Montagne decided to profitably increase production of electrolytic zinc using zinc ore as the basic material. The zinc ore delivered for processing at the Balen plant has the following average analysis: 60% Zn; 31% S;



FLOWSHEET I At Balen, lead-rich residues are combined in closed-circuit with zinciferrous slags. By-products are removed where their concentrations are highest.



FLOWSHEET II Roasted zinc ore and zinc oxide are leached separately because of high lead content of the fumed oxide. Solutions are then purified for electrolysis.

2% Pb; 0.5% Cu; 0.3% Cd; 2% Fe; 1% Si; 0.03% Ag; 0.01% Hg; and 0.005% Ge after flotation.

The decision taken at Balen to utilize basic ore as well as zinc oxide was two-fold — firstly, the roasting plant's operating economy could be increased to a maximum and the roasting equipment could be run on a profitable basis, and, secondly, in addition to the impure oxides from the fuming process, the electrolysis process could be provided with a source of relatively pure roasted material. (See flowsheet II.)

Ore & Oxide Leached

By leaching the two materials (ore and oxide) in duplicate leaching circuits, Vieille-Montagne was able to dissolve out the zinc together with other soluble elements as cadmium and a portion of the germanium, amongst others, whereas the insoluble elements remained in the residue. The insoluble residue contains lead, insoluble zinc compounds, copper, silicic acid, and a trace of germanium. But the actual composition of the insoluble sludge differs very radically depending entirely on which of the two raw materials is leached. For this reason, researchers at Vieille-Montagne decided to leach the roasted zinc ore and the zinc oxide in separate processes. The leached residue of the fumed oxide has a relatively high lead content but very little zinc whereas the sludge left after leaching the roasted ore has a relatively high content of zinc but an equally low content of lead.

Sludge left after the fumed oxide is leached is cycled to the lead plant whereas the residue left after leaching the roasted ore is cycled back to the sublimation or slag-fuming plant for re-cycling. This, say researchers and engineers at Vieille-Montagne, only goes to prove the correctness of their theory that only an integrated lead and zinc plant can be run at a high operating efficiency and at maximum profit.

Theoretically, nothing of any practical value is lost and any or all of the elements which are recoverable are re-cycled through the process until they can be recovered completely.

Before electrodeposition can take place, the solution must be carefully purified, the whole success of the process hinging on the high degree and properness of the purification process. This fact is due to the high position of zinc in the electro-potential series of metals for not only will the metals below zinc—copper, iron, nickel, cobalt, arsenic and antimony, etc.—be deposited with the zinc if any or all are present in the solution, but their deposition will set up electrolytic couples that cause re-solution of the zinc by the sulphuric acid present in the electrolyte. This will result in low current efficiency, spongy zinc deposition, impure zinc, etc. At Balen, the solution is processed to retrieve germanium and, principally, cadmium plus other impurities present in lesser quantities. The zinc-sulphate solution is heated with steam coils and treated with zinc dust to precipitate out a sludge containing mostly cadmium. The purified solution is cycled to the electrolysis cells.

The residue from the precipitation plant is processed further to give a cadmium-sulphate solution, a germanium concentrate, and a residue containing copper, cobalt, nickel, arsenic, etc.

Presently, the zinc electrolysis plant operating at Balen is daily producing 175-tons of zinc. This shows that zinc oxide from the sublimation or fuming process is no longer the major of the two basic materials. The zinc blende yields by far the larger proportion of the material cycled to the electrolysis plant for conversion to 99.995% zinc metal.

Lead Plant

Prior to the controlled removal of sulphur on a Dwight-Lloyd sintering machine, lead ore is mixed with residue from the horizontal retort zinc furnaces and the lead-rich residues from the electrolytic plant. The gases drawn off during sintering contain about 5% SO_2 and are electrostatically precipitated before being fed to a Petersen Plant for processing to sulphuric acid.

The lead blast furnaces at Balen were founded originally in 1910 but the small blast furnaces installed when the plant was new have now been replaced by modern furnaces with cross-sectional area at the tuyere zones of

about 78 sq ft. The pre-heated air entering the tuyeres from the bustle pipe is heavily enriched with oxygen.

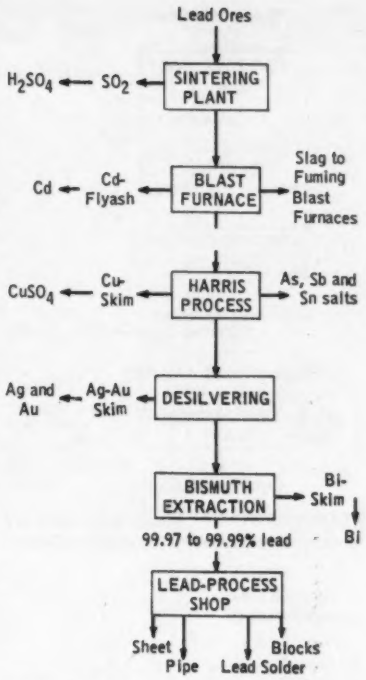
After treatment of the ore-residue mixture in the lead blast furnaces, slag with quite a high proportion of zinc is passed to the fuming or sublimation furnaces for further processing to zinc oxide. After siphoning the metal from the furnace crucible to the lead well, the metal is drossed in a kettle. Here copper is skimmed off in the form of a sulphide and the lead bullion is subjected to a Harris process for the removal of arsenic, tin and antimony in the form of saleable salts.

Desilvering by Parke's Process

Desilvering is done in the normal Parke's process manner, the zinc crust which is removed from the desilvering kettle being treated for the recovery of silver and gold which are subsequently parted and refined. Bismuth, which is not removed by the Parke's process, is subsequently extracted by adding metallic calcium and magnesium which, on forming compounds with the bismuth, rise to the top and are skimmed off. The high-bismuth content dross is remelted and oxidized prior to being cast to anodes. During electrolysis, high-purity lead is formed and the undissolved bismuth in the form of a slime is collected and treated for the recovery of the metal.

Skimmings from the drossing process are processed further in a small reverberatory furnace by stirring in sulphur. The copper matte containing 50% copper is processed to recover copper sulphate, whereas the speiss, a copper-arsenic compound, is sold to the market. The lead bullion recovered during this softening process is re-cycled to the Harris process for the removal of arsenic, tin and antimony.

The flue gases from the lead blast furnace are electrostatically precipitated; the flue dust collected in the precipitators containing 50% lead plus from 5 to 10% cadmium which is cycled to the cadmium extraction plant as one of the major raw materials.



FLOWSHEET III In the blast furnace, pre-heated air is enriched with oxygen.

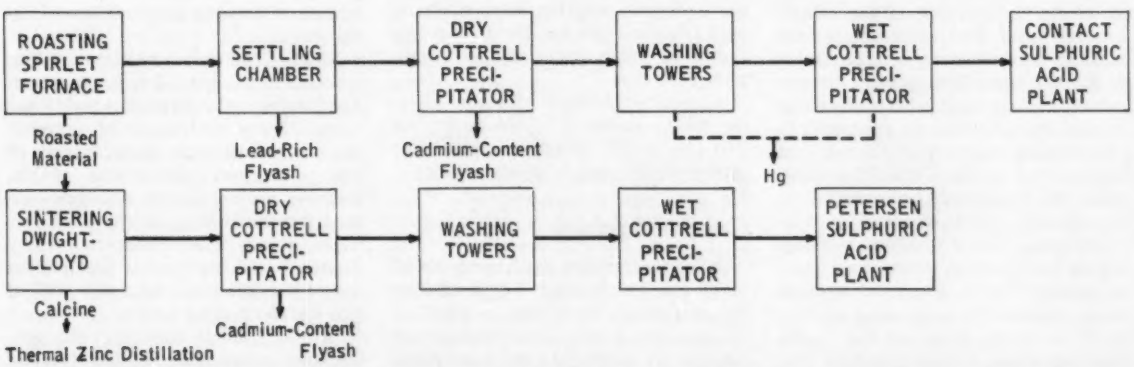
The Balen lead plant can produce upwards of 40,000 tpy of commercial pig lead with purity grades ranging from 99.97 to 99.995% as per customer's specifications. A lead rolling mill located almost adjacent to the lead plant mills a portion of the produced lead to pipes, water siphons, lead wire, sheets, and to solder wire. The rolling mill fulfills a dual purpose in that it fashions the silver-content anodes required by the company's zinc electrolysis plant. (See flowsheet III.)

Zinc Distillation and Sulphuric-Acid Plants

With the exodus of the old chamber method of producing sulphuric acid in favor of the more modern contact method, it became increasingly more essential to process the flue gases to a higher degree of purity. This had though, the added advantage that the flue dust precipitated out during purification contained a higher volume of valuable by-products which were worthwhile recovering. (See flowsheet IV.)

Flue gases from the roasting furnaces at Balen are passed through dust settling chambers to a dry Cottrell precipitator, a battery of washers, and then a wet Cottrell precipitator, arranged in that order. The dust extracted from the settling tanks is rich primarily in lead and is therefore cycled to the lead plant. The dry Cottrell precipitator delivers dust containing cadmium enough to warrant cycling to the cadmium extraction plant. The last two purifying units, the washers and the wet Cottrell, discharge a slime containing primarily lead but also nearly all of the mercury content of the ores. After distillation from the slime, the mercury is passed to a company-owned mercury refinery whereas the lead-rich residue from the distillation process is cycled to the lead plant where this metal, and other incidental metals, are extracted.

As long ago as 1924, management at Vieille-Montagne was aware of the advantages to be obtained from a two-stage roasting of the zinc ores to attain a better control of the percentage of sulphur left in the blende. After roasting in a conventional Spirlet furnace, ore is mixed with solid fuel and finally dead-roasted in a Dwight-Lloyd sintering machine. In addition to roasting out the sulfur in the blende, the sintering process sublimates the lead and cadmium left after the initial



FLOWSHEET IV Following purification by precipitation, flue gases from three moving-bed furnaces are piped to contact sulphuric acid plants. Heat exchangers coupled to the furnaces provide steam which is piped to the power plant.

more and more zinc was recovered by the electrolysis method through the ensuing years, more and more importance was attached to the cadmium-containing leach residues. Today, at Balen, these are the main sources of cadmium and a method of processing had to be devised whereby cadmium could be recovered from the leach residue and also from the flue dust in much the same manner. The management aimed at, and got, a single process instead of having to run two parallel extraction methods. (See flowsheet V.)

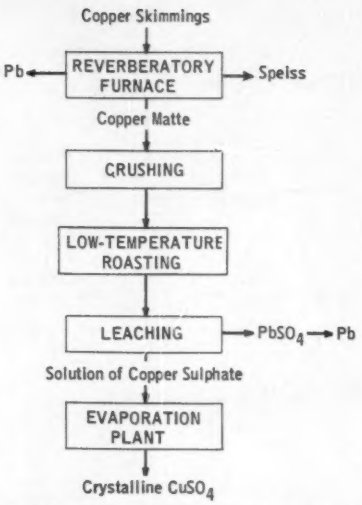
Cadmium In Closed Circuit

Even at the time when the cadmium extraction plant was first installed, technicians at Balen specified a closed-circuit method of working so that any cadmium, or any other by-products for that matter, not recovered directly during the extraction process, would be cycled back into the system and would eventually again reach the direct-recovery plant.

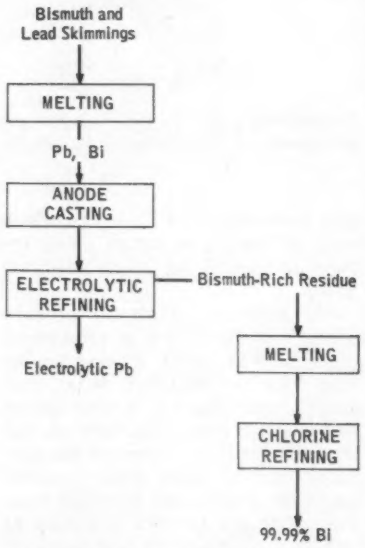
The method devised by the Balen scientists to process cadmium prior to its recovery is seemingly complex but this was done purposely with the idea of making the recovery of other by-products possible. As other by-products are extracted, they are cycled to an auxiliary installation of some kind within the closed circuit where further processing takes place.

As an example, after leaching the dusts containing Cd in sulphuric acid, the residue left contains about 50% lead. As such, it is an ideal charge for the lead-blast furnaces. And during the precipitation of cadmium with zinc dust, a zinc sulphate solution will be formed which can be used sucessfully and to every advantage as the wetting agent for the zinc blende passed from the roasting to the sintering plants.

Cadmium sulphate solution coming from the zinc electrolytic plant differs little, if at all, from the solution obtained by the leaching of the cadmium-rich dusts. The cadmium present in these two solutions is precipitated by the zinc dust. The metallic impure cadmium slime obtained is re-dissolved in sulphuric acid; this solution goes to a purification stage where the thallium is recovered in the form of a chromate. This is extracted and passed to a processing plant where it is converted either to a thallium sulphate (which is the base material of most rat poisons) or is processed to high purity metal with a grading of 99.-999% thallium. Some of the recovered chromate is processed in the company installation to thallium iodide and to thallium chloride.



FLOWSHEET VI More than 4000-tpy of copper sulphate are produced at Balen.



FLOWSHEET VII Annual recovery of bismuth is about 60 tons at Balen plant.

After leaving the purification stage, the cadmium solution is electrolyzed with insoluble anodes, the high-purity cadmium being deposited on aluminum cathodes.

Annual production of cadmium at the Balen works is in the region of 750 tons which makes this plant one of the world's major producers.

Copper Sulphate

A copper matte containing about 50% Cu is obtained by processing the skimmings from the lead-bullion drossing plant in a small reverbatory furnace by stirring in sulphur. After roasting the matte at a relatively low furnace temperature, it is leached with sulphuric acid to produce a solution of copper sulphate and a residue relatively rich in lead.

The high lead content residue is returned to the lead blasting furnaces. the solution of copper sulphate is evaporated and the copper sulphate is recovered in the form of crystals ready for commercial sale. The mother liquor is re-cycled back to the matte leaching solution. In excess of 4000 tpy of copper sulphate are produced at Balen. (See flowsheet VI.)

Bismuth

The bismuth-rich skimmings obtained by adding metallic calcium and magnesium to bullion lead are melted and oxidized. The bismuth-lead melt is cast to anodes prior to electrolysis in a hydrofluosilicic electrolyte. Pure lead cathodes and a bismuth-rich residue are obtained after electrolysis. The residue is melted and then refined with chlorine prior to casting the metallic bismuth to small blocks.

Annual recovery of bismuth at the Balen plant is about 60 tons. (See flowsheet VII.)

Germanium

The presence of increasing amounts of germanium in the electrolyte feeding the zinc cells early caused Balen technicians to devote much energy and expense to the recovery or, better, the elimination of this troublesome metal. The direct result of this was that, as the importance of germanium as a semi-conductor material was recognized, and the demand grew increasingly, the Balen installation was in a position to go into full-scale germanium-recovery operation. In 1947, Vieille-Montagne erected the first installation in Europe for the recovery and the production of electronically-pure germanium metal and germanium oxide. Despite having to process a raw material which is relatively low in its content of germanium, the Belgian factory is today, one of the world's major producers of the valuable metal.

Most of the recoverable germanium is found in the calcine from the roasting furnaces, the amount varying between 10 and 400 grams of germanium per ton of zinc calcine. Most of the germanium passes out of the leaching process in the zinc-rich residues for the fuming in the blast furnaces, a very small proportion being dissolved with the zinc is precipitated out of the solution before this is filled into the electrolytic cells.

In the fuming furnaces, the germanium in the leach residue is volatized simultaneously with the zinc and will be found again in the zinc oxide

roasting, these two metals in the form of oxide passing with the flue gases to the gas purification plant. In 1954, the company installed a 120-tpd Cominco flash roaster coupled to a heat-exchange boiler supplying live steam at 570 psig to the company's power plant. Though an improvement, flash roasting did not provide the final answer and researchers at Balen experimented with a 30-tpd pilot floating-bed furnace. The pilot plant was later enlarged to 65-tpd crude ore. Results obtained from the pilot plant indicated that a moving-bed furnace was the best answer so that management at Vieille-Montagne decided to install two large 130-tpd furnaces at the Balen facility. The first was completed in 1958, the second late in 1960, and the present 65-tpd pilot plant is scheduled soon for dismantling and rebuilding to handle at least 130-tpd crude ore, or maybe more. Heat exchangers coupled to all three furnaces provide steam which is piped directly to the power plant.

Following purification by precipitation, the flue gases from the three furnaces are piped to newly-installed contact sulphuric-acid plants engineered to yield 110-tpd each of pure sulphuric acid.

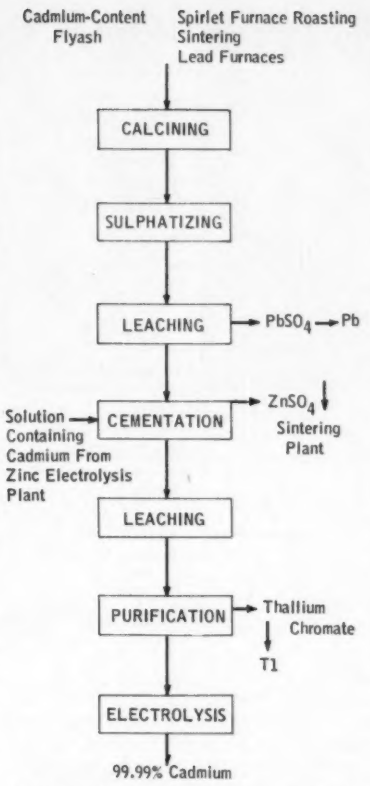
In addition to providing calcine for processing in the electrolysis installation at Balen, the capacity of the three furnaces at this plant was high enough to provide nearly all the roasted ores required to feed the company's zinc-distillation furnaces located at nearby Liege.

The Balen roasting plant now handles 200,000 tpy of crude zinc ore and, in the adjacent sulphuric acid plant, produces an annual volume of 200,000-tons of sulphuric acid at 60° Bé.

Fuming Process

Primarily, the fuming or sublimation furnaces at Balen were built to recover the 15% Zn, 2% Pb, and 0.5% Cu lying idle in the thousands of tons of slag deposited from the Balen lead plant. The company-designed furnaces are charged with a mixture of the old slag and coke. During the slag-fuming process, the slag is partially reduced to an oxide rich in zinc and lead, to a matte containing copper mainly, and traces of noble metals, and a residue which, to all intents and purposes, is free of all recoverable metallic compounds.

The zinc oxide recovered from the fuming furnaces contains a very high proportion of lead oxide together with some tin. This latter is an adulteration in the zinc and prohibits distillation in muffle retorts for the resulting metal is too friable for normal rolling. Superior, and most feasible method of processing the zinc from the fuming furnaces was, therefore, electrolysis, and this presented little or no problem at the Balen installation for the reaction in the fuming furnaces released large volumes of combustible gases which could be used very satisfactorily to heat boilers in the power plant. The steam thus generated was used then to generate part of the electric current required for the electrolysis process. The process circle was finally closed when experiments proved that the leaching of the wasted zinc ore prior to its passing to the electrolysis cells produced a low-zinc high-lead residue which could be used as charge in the fuming furnaces.



FLOWSHEET V Cadmium extraction plant handles both flue dust and leach residue.

Residues Are Mixed

However, the processing of this leach slime presented a problem to the Balen engineers for, in order to obtain an efficient furnace charge, and in order to allow a free passage of reaction air through the furnace structure, the material of the charge should be lumpy. Vieille-Montagne researchers solved the problem by mixing ground slag with the pre-dried leach residue, and by mixing in coal. The homogeneous mixture was then pressed to small size briquettes.

Furnace throughput was increased quite considerably at Balen by adding oxygen to the fuming-furnace wind, and coke consumption was reduced. In order to make the whole Balen installation as self-supporting as possible, the management built a new 60-tpd tonnage oxygen plant employing the well-known Linde process.

Three factors, say Balen engineers, have been responsible for a heavy reduction in the operating costs of this section of the installation—firstly, converting a portion of the charge to lumps, secondly and simultaneously, by substituting coal for a portion of the reducing coke, and thirdly, adding oxygen to the air blown through the furnaces. Still not content with the already low overhead of the fuming operation, the plant management looked round for other ways of cutting costs. Practice so far had been to precipitate the metallic oxides out of the flue gases in wet precipitators. This meant that the oxides were obtained in a wet slime-like form, added to which the sensible heat of the exhausted gases could not be usefully exploited. Modifications made to the fuming furnaces at Balen allow the combustible gases to be ignited immediately on leaving the furnace proper. The heat generated is transferred to heat exchangers and the cooled gases are passed through a normal bag filter. In this way, the oxide is recovered in a form which allows it to be used straight away in the elctrolysis plant.

The battery of furnaces now in operation at Balen will handle 150,000 tons of slag plus other residues, in the course of a year.

Cadmium

Before the installation in 1935 of the zinc electrolysis plant, the main sources of cadmium at the Balen installation were the dust precipitated out of the flue gases of the Spirlet furnaces, the dust filtered out of the flue gases of the lead blast furnaces, and dust precipitated out of the electrostatic filters processing the flue gases from the two-stage roasting plant.

Increasing commercial demands for this metal together with the fact that the cadmium-content of the flue dusts was high enough to make recovery worthwhile, instigated the management at Balen to build, in 1931, a cadmium-recovery plant. Even though the dust content was high, the amount of cadmium recovered was relatively small measured on world standards, and did not attain major significance until the introduction in 1935 of the first zinc electrolysis installation. As

cycled to the leaching plant. Continual re-cycling causes a gradual build-up of germanium to such an extent that zinc oxide for treatment in the electrolysis plant often contains upwards of 0.1% Ge which is 20 times more than is normally found in zinc ores.

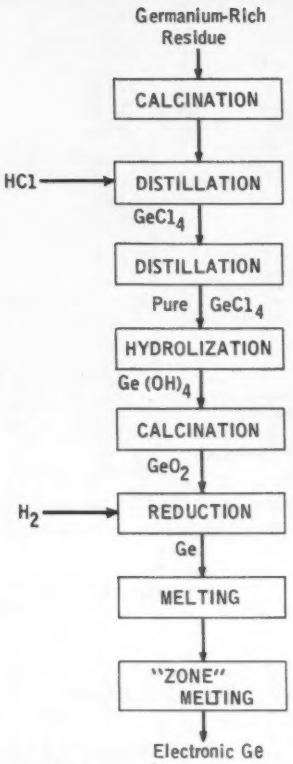
The obvious place to extract germanium from the closed circuit was the point where its concentration was the highest, i.e. after leaching the zinc oxide. Leach residues containing up to 0.3% Ge are washed with water to dissolve out the readily-soluble germanium, the solution is then filtered and the germanium precipitated to a cake containing between 2 and 3% of the metal. By heating the concentrate together with hydrochloric acid, a tetrachloride is formed which can be distilled and condensed. Following distillation in a chlorine medium removed most of the arsenic in the impure tetrachloride, the arsenic being cycled out of the circuit for separate processing.

HCl Aids Purification

Purification of the tetrachloride is standard in that it is passed through seven separate distillation flasks. But Balen scientists found that by introducing an extremely pure hydrochloric acid into each flask prior to distillation, the impure tetrachloride had to pass through seven acid beds which dissolved out most of the residual impurities in the tetrachloride. Pure germanium tetrachloride is then passed drop by drop into an agitator vessel containing low-ion content water. After hydrolization, the germanium hydroxide is filtered out using only plastic-material filter cloths to prevent metallic contamination.

Electrically-heated furnaces dry out the hydroxide cakes to a germanium dioxide powder which is then sieved through a vibrating screen.

In the presence of hydrogen gas, the germanium dioxide is heated slowly in a tubular-shaped furnace and unmelted metallic germanium in the form of a powder is formed at about 1200° F. Maintaining the flow of dry hydrogen gas, the temperature in the tubular furnace is raised gradually to about 1830° F. The bar of germanium removed from the furnace after cooling is highly pure but not pure enough to meet the requirements of the electonics industry. Purification, at Balen, is carried out using a so-called "zonal melting" process which relies for its success on the fact that impurities are more soluble in a melted substance than in a solid substance. The melted zone in the bar of germanium metal is made to travel from one end of the bar to the other and so carry all the impurities to the one end of the bar.



FLOWSHEET VIII Refinery at Balen is one of world's major germanium sources.

The bar of germanium metal to be purified is positioned in a graphite runner moving at a speed of ⅜-in. a minute along the length of a quartz tube. During the actual refining, the bar of metal is surrounded by an atmosphere of dry, pure argon gas. Six heating coils fed with a radio-frequency current to keep the melt zone as narrow as possible, are located around the outside of the quartz tube. (See flowsheet VIII.)

Based on their experience gained with the purification and refining of germanium, Balen scientists have recently turned their attention to germanium's rival in the electronics field, silicon. In the Balen laboratories, silicon of the highest purity grade is being produced with the help of a "zonal melting" process. In this case, the bar to be refined is positioned vertically and is rotated at quite a high speed during the processing.

Mercury

The amount of mercury contained in the blende varies between zero and 0.6%. During roasting, the mercury volatizes and is deposited in the sludge discharged from the wet Cottrell precipatators. After drying the sludge, this is caked and processed in a muffle furnace to distill out the mercury as an impure metal. The residue left in the muffles is rich in lead sulphate and is therefore recycled to the lead blast furnaces. The impure mercury is distilled in an air-tight chamber in the normal manner, the impurities are oxidized with air, and the condensed metal is then finally filtered in a conventional Golden filter installation.

Annual production of mercury is, obviously, heavily dependent on the amounts of mercury contained in the blende. On the average, the Balen works produces more than 5 tons of mercury per year.

Book Review

RESOURCES FOR THE FUTURE INC., has published another valuable booklet on our national resources under the title, **"The Future Supply of the Major Metals,"** by Bruce Netschert and Hans Landsberg. The authors define their objectives as follows:

"The present study is a reconnaissance survey; in no sense is it definitive. Because of the crudeness of available data the results can only be first order approximations. The figures for future demand used in the report are in no sense predictions or forecasts; they are merely illustrative of what might be expected to develop under certain assumptions."

Major metals included in the study are iron ore, manganese, aluminum, copper, lead and zinc. Each metal is analyzed under these headings: domestic reserve-resource position, domestic supply versus demand, world reserve-resource position, and world supply vs demand.

Projections made by the author extend to the year 2000, with the assumptions that during the next 39 years there will be no major depression or armed conflict. Gross national product is expected to increase at the rate of 1.7% per year.

Population in the U.S. is expected to increase from 180-million, today, to about 330-million by 2000. Aluminum appears to show the greatest potential for increased use, principally because of growing use in the transportation field. Projected requirements for various metals for the 1960-2000 period are: iron ore, 5-billion long tons; aluminum, 390-million short tons; copper, 100-million short tons; lead, 40-million short tons; and zinc, 70-million short tons. Published by Resources for the Future, Inc., 1775 Massachusetts Ave., N.W., Washington 6, D.C. Pages, 65. Price $1.00

ADVANCE PLANNING of phosphate lands before mining, including land contour, in-process moving of dragline, power lines and pipelines, depth of overburden and availability of tailings material create conditions for reclamation of mined-out lands at the Sydney Mine in Hillsborough County, Fla. This year, Cyanamid will reclaim more land than it will mine.

In Florida's phosphate fields . . .

Cyanamid Reclaims Land As It Mines

A CHANGE IN MINING TECHNIQUE, to a deliberately less economical method, has been undertaken by American Cyanamid Co.'s agricultural division in Florida. The average dragline cut in previous mining cycles in Florida has been about a quarter mile in length. Cyanamid is now holding its cuts down to 400- to 550-ft lengths and, also contrary to former practice, is distributing overburden in mined-out areas at nearly ground level instead of building high windrows.

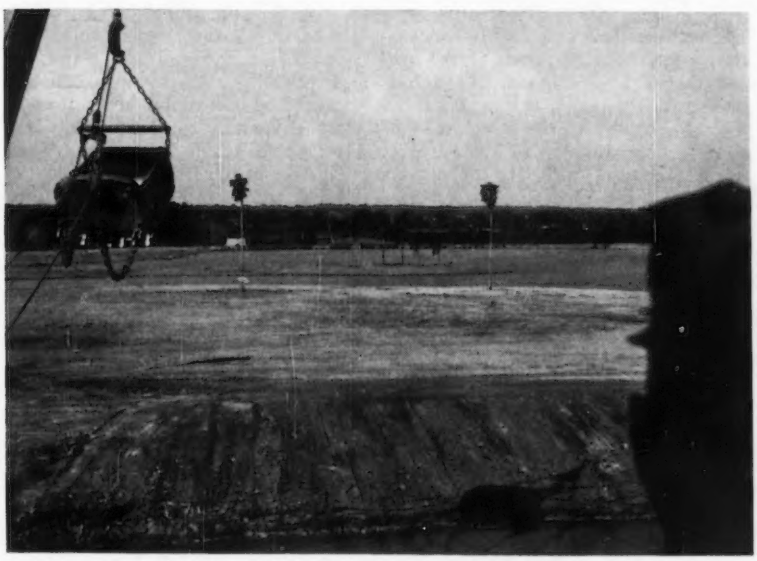
Cyanamid's purpose in the change is the reclamation of mined lands, carried on simultaneously with mining. It is hoped that the new, level lands, after a rather lengthy settling period, can be used for the establishment of citrus groves or for homesites.

The key to the program, according to mines manager E. M. Haynesworth, is through advance planning. "As restoration of the land is an integral part of Cyanamid's mining operations, we can incorporate it into our plans," he says. "Since early 1960 we have been carrying out simultaneous mining and reclamation, and have developed mining plans in accordance with this activity."

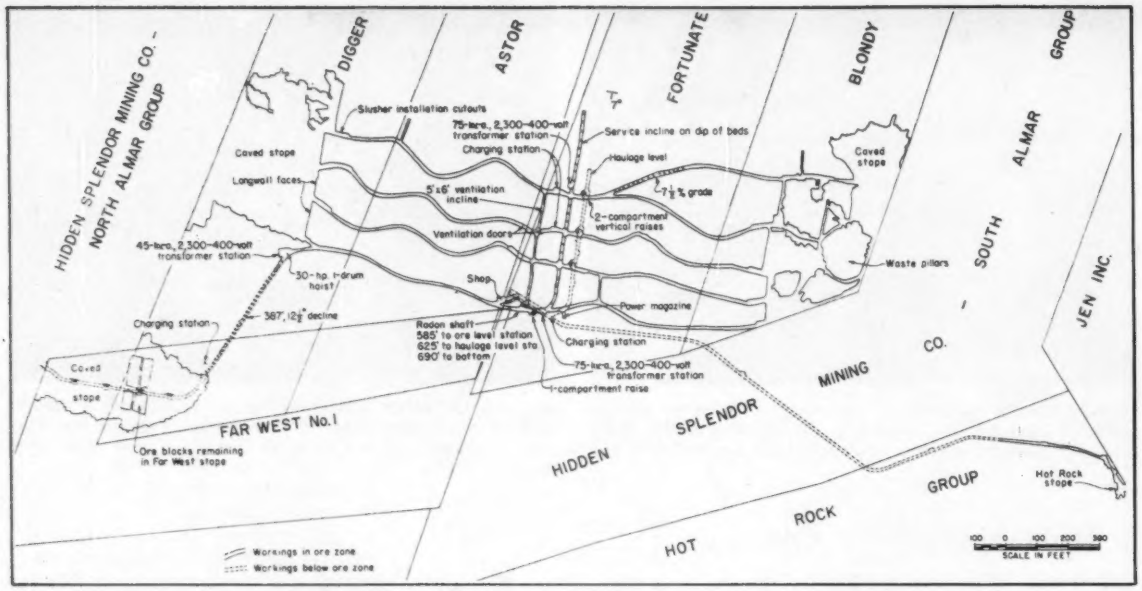
Step one in the advanced plan is study of land contours both of the overburden to be removed and of the surrounding lands. Reclamation is then planned to fit the surroundings: high ground adjacent to roads, low areas near lakes or ponds.

Step two is the breaking down of the large tracts of land for mining, all with eventual integration of the smaller areas to fit into the reclamation blueprint.

Arthur Crago, manager of phosphate operations for Cyanamid, noted that the firm has been experimenting with land reclamation since 1949, and that the reclamation method developed by Mr. Haynsworth will be extended from the three areas where it is now in operation to other sectors. The method, while more expensive as a mining technique, lowers the cost of subsequent reclamation. The areas now being reclaimed are at Sydney, where two separate tracts are under development, and at Orange Park, where 170 acres more are being mined and reclaimed simultaneously. The posts of mines reclamation and preparation supervisor are being filled by Harry W. Abercrombie at Orange Park and by Cecil P. Hagan at the Sydney. Mines planning is under S. C. Watkins.



THE SAME 18-CU YD DRAGLINE that mines the phosphate and clears overburden also functions as the prime reclamation tool, along with bulldozers and haulers. Key to the mining method is a shorter cut, less economical for mining purposes, but the basis for future grading. Land may be used for the establishment of citrus groves or homesites after a rather lengthy settling period.



FROM THE START, Radon was a planned mine. Four principal stoping areas are served by a centrally located, 3-compartment shaft. From the shaft, contour strike drifts were driven through the orebody to the outer claim boundaries.

USBM Details Longwall Stoping Operations at Hecla's Radon Mine

IN A RECENT USBM PUBLICATION, W. L. Dare and P. M. Lindstrom detailed Hecla Mining Co.'s operations at the Radon uranium mine near Moab, Utah. Radon is the only metal mine in the U.S. to use the longwall retreat system and is one of two in North America, the other being the San Francisco manganese mine at Autlan, Jalisco, Mexico.

Hecla's manager of mines, W. H. Love, and superintendent of Utah operations, P. M. Lindstrom, gave Hecla's reasons for selecting the longwall method when they said in a talk before the American Mining Congress that, besides having an orebody suitable for longwalling, "the longwall method also offered an opportunity of doing a good clean job of mining the high-grade ore. Clean mining has two distinct advantages. Although mining costs per ton are possibly higher than for the room and pillar method, the cost per pound of uranium produced is lower. In addition, the Atomic Energy Commission buying program offers substantial premiums for producing maximum grade ore."

From late 1956, when the mine began production, through 1959, total mine output was 258,644 dry tons assaying 0.65% uranium oxide. Present ore production is about 260 tpd.

The tabular Radon orebody is about 2150 ft long, 400 to 700 ft wide, and lies between 550 and 750 ft beneath the surface. The thickness of the ore has ranged from 1 to 8 ft and has averaged 4½ to 5 ft. Its trend is roughly parallel to the strike of the beds, or approximately N 10° W, and its dip is about 7° SW. The orebody is part of a large mineralized zone that trends about N 23° W along the southwest flank of the Lisbon Valley anticline.

The Radon orebody lies along the bottom of the basal or Moss Back member of the Chinle formation, which consists of about 420 ft of red and green mudstone and siltstone, interbedded with conglomerate and fine-grained cross-bedded sandstone. Usually, the ore lies within 2 ft of the contact between the Moss Back member and the underlying Cutler formation. Ore occurs principally within a gray sandstone stratum that usually contains a coarse-grained arkose (or quartzose) lens. Uraninite, the ore mineral, occurs as disseminated particles. The highest grade ore is almost always the arkose lens.

The Radon and the Hot Rock Group of claims (see map), which were located in 1953, near Charlie Steen's Mi Vida discovery, are controlled by Federal Resources Inc. Hecla operates the mine under royalty and profit-sharing agreements with Federal.

In 1954-55, the Radon group was explored by chemical analysis of cores from diamond drill holes while the Hot Rock group was explored in 1955-56 with 39 holes under a DMEA contract. The upper portions of the holes were drilled with a 4½-in. rotary and the lower portions with a Mayhew 1000 drill rig equipped with NX bits. Altogether, 68,458 ft were drilled at a contract price of $2.75 per ft for noncore drilling and $4.50 a ft for core drilling.

Hecla Develops Orebody

To develop the orebody, Hecla sank a 3-compartment, 690-ft vertical shaft to intersect the deposit about midway along its downdip edge, thus limiting haulage distance to 1100 ft maximum. The dry shaft is equipped with a 6-in. compressed air line, 2-in. waterline, 2-in. shaft sprinkler line, 30-in. metal ventilation duct, 2300-v lead-covered power cable and tele-

This article is abstracted from *Mining Methods and Techniques Used at the Radon Longwall Operation, Hecla Mining Co., San Juan County, Utah*, USBM Information Circular 8004, by W. L. Dare and P. M. Lindstrom.

phone and hoist signal cables. Douglas-fir sets (8x8-in.) for the two hoistways and one manway are 4 ft 4 in. x 5 ft 6 in. in the clear. They are hung on 5-ft 3-in. centers and tightly lagged with 2x10-in. cedar.

Two stations were cut from the shaft, one on the ore level (585 ft), and the other farther down in waste (625 ft). From a point about 90 ft south of the upper station a 7x8-ft service incline was driven 640 ft updip on a bearing of N 80° E. This incline, the main entry to the stopes, approximately bisects the orebody and extends about 40 ft in waste. It is tracked with 30-lb rail on 24-in. gage. A single-drum, 7½-hp air tugger hoist, anchored at the upper end, hoists the supply and tool cars to the levels. C. S. Card ball-bearing turntables are set at each level intersection. A parallel 5x6-ft ventilation incline, driven updip opposite the manway compartment of the shaft, also connects shaft with strike drifts.

Four 7x8-ft drifts, driven along the strike in both directions from the service incline to the claim boundaries, divide the main Radon orebody lengthwise into irregular strips. Measured along the dip, the drifts are an average of 120 ft apart; measured vertically, they are 20 ft apart. In driving the drifts, more emphasis was placed on keeping the contact in sight than on keeping the drifts on a fixed grade. Because of local irregularities along the top of the Cutler formation, the miners drove the headings on a somewhat winding course to keep ore exposed and openings near level.

The lower haulage station, a 12x7-ft drift along the wall-plate side of the shaft, terminates 50 ft to the north. On the shaft side of the drift, a 5x10x50-ft slusher loading pocket was cut into which the mine cars are dumped and from which 50°-inclined, 49-cu-ft skip measuring pockets are loaded.

On the south end of the slusher pocket a 7x8-ft tracked haulage drift was driven N 80° E (the same bearing as the dip of the beds) under and at right angles to the four strike drifts. Vertical raises (the longest is 90 ft high) connect the haulage level to each strike drift. Two 40-ft-high, one-compartment raw ore passes were raised near each end of the slusher trench directly to the lowest strike drift; two-compartment raises, manways cribbed off from the untimbered ore passes, connect the haulage level with the other three strike drifts.

Two small outlying orebodies, which are extensions of other large orebodies that extend into ground of Federal Resources Inc., are developed through the Radon shaft (see map).

All development work was completed under incentive contracts. In a standard 8x7-ft development heading, a crew received $10 per lineal ft of advance, which included payment for laying track and hanging pipe. Six men, three on a shift, made up a contract crew on a strike drift level. Both jumbos and airlegs were used.

Except at the shaft stations and chutes, no timber has been used for back support in the development headings. Roof bolts were used extensively. Power is distributed underground from two 75-kva, 2300-400 v, centrally located transformers near the upper and lower ends of the service incline and a 45-kva, 2300-400-v unit near the hoist station at the top of the Far West incline.

Longwall Is Coal Method

The tabular, gently dipping Radon orebody is being stoped by a longwall system patterned after the coal mining methods used in many European mines. The longwall faces retreat from the north and south property lines parallel to and toward the service incline. The ore is broken out in 4-ft slices, and the supported back—a strip that ranges from 7 to 12 ft in width—is held by two rows of steel props and an intermediate row of cribs. The back is allowed to cave as the supports are moved forward; the cave is fully controlled. Scrapers pull the ore downdip to the nearest drift, where it is loaded and transported by conventional track equipment. No underground water has been encountered. Retreating, followed by full caving, was chosen to gain complete and selective extraction of the high-grade orebody.

When planning a stoping method, a system which required a minimum of openings was attractive. Room-and-pillar mining would not yield the desired recovery primarily because of the weak rock that overlies much of the ore. Weak backs would have increased the problem of ore dilution, and probably would have resulted in the loss of ore in unrecovered pillars. In longwall mining, a weak back is an advantage because the back must fall soon after the supports are withdrawn, provided that the back is not so soft as to permit the props to penetrate it. A strong back, or one which breaks abruptly, is usually difficult to control along a uniform break line. Because of the thinness of the orebody, Hecla chose small conventional production equipment that would not require overbreaking to gain operating height.

The focal point of Radon stoping is the back support method. All phases of the stoping operation are keyed, at least in part, to the capabilities of the Becorit yieldable steel props and supplemental cribs. Much of the published information concerning the current practice of steel-prop support in European coal mines was consulted in planning the stopes. Only light charges, if any, are used to break the much softer coal, whereas heavy charges are necessary to break the ore. At the Radon mine, the props have a secondary function, that of supporting blasting boards that confine the ore.

The north and south claim boundaries of the Radon orebody lie 10-40° obliquely off the bearing of the dip of the beds. Therefore, at both ends of the property the first longwall cuts taken from the ore were wedge shaped so that the faces would lie on the dip. Mining the longwalls on the dip has two advantages: The longwall scrapers travel better between the face and the blasting boards; final recovery at the service incline is easier.

Drilling Begins Cycle

Longwall blast holes are drilled 4-ft deep in vertical rows of 4 holes each spaced about 18 in. apart with 45-lb airlegs equipped with ⅞-in. hexagonal steel and one-use, 1⅝-in. TC insert cross bits. Vertically, the two center holes in each row are staggered according to the height of the ore; however, at least one hole is placed in the harder arkose lens for good fragmentation. All holes are drilled as nearly normal to the plane of the face as possible. The maximum number of 4-ft holes drilled by one man in an 8-hr shift was 168; two partners drilled a record 331 4-ft holes in one 8-hr shift.

After a longwall round has been drilled, 16-ft lengths of 2x8-in. oak lagging are strapped with heavy-duty steel packaging bands on the face side of the inner row of props to confine the ore. Oak, at $155 per M proved cheaper than previously used fir at $118 per M because it lasted longer. In 1959, Douglas fir lagging averaged 13¢ per dry ton of ore hoisted. The 0.035x¾-in.x4-ft bands cost nearly 10¢ apiece or about $7.50 for enough to lag off a 100 to 110-ft stretch of longwall face.

Blasting begins at the strike drift on the downdip end of a section of a longwall face. In the first round, 10 to 20 rows (40 to 80 holes) are shot, whereas 6 to 10 rows (24 to 40 holes) are shot in succeeding rounds. The holes, which are detonated from the bottom up to reduce throw, are loaded with 1⅛-in.-dia Trojan Trojamite C dynamite, primed with No. 6 caps, safety fuse and Thermolite igniter cord. The contractors blast at any time during the shift, but station themselves at points of access to the stop-

TABLE 1, Principle Equipment

1 locomotive, 4-ton, battery, Mancha.
4 locomotives, 3-ton, battery, Mancha.
1 locomotive, 3-ton, battery, General Electric.
1 locomotive, 1½-ton, battery, General Electric.
5 loaders, overhead, Eimco 12B.
15 rock drills, air-leg-mounted, Cleveland H1OAL (AL-92 leg) and Ingersoll-Rand JR-38A & BB (AL-93 leg).
1 rock drill, air-leg-mounted, dry, Cleveland LLV, with Cleveland LXI dust box and AL-92B leg.
2 rock drills, Holman Dryductor.
3 rock drills, stoper, Ingersoll-Rand R-58.
2 rock drills, stoper, Ingersoll-Rand RP-38.
5 paving breakers, Ingersoll-Rand PB-59.
4 impactools, Ingersoll-Rand 534.
2 hitch cutters, Ingersoll-Rand 273.
20 mine cars, 41-cu-ft, Granby-type.
10 mine cars, 40-cu-ft, rocker-type.
2 scraper hoists, 3-drum, 20-hp, electric, Joy A2F-311 and B2F-311.
9 scraper hoists, 2-drum, 20-hp, electric, Joy A2F-211.
2 scraper hoists, 2-drum, 10-hp, electric, Joy FF-211.
2 scraper hoists, 2-drum, 10-hp, electric, Ingersoll-Rand 10NN-IF.
1 scraper hoist, 2-drum, 5-hp, air, Joy S-211.
2 tugger hoists, 1-drum, Ingersoll-Rand EU and HU.
1 tugger hoist, 1-drum, 500-lb-pull, air, Joy AW-80.
2 pumps, centrifugal, 2-in., 7½-hp, Fairbanks-Morse 5553B.
1 pump, Gardner-Denver, duplex steam, 2½ by 1½ by 3.
1 hoist, double-drum, 100-hp, 7500-lb-pull, 425-fpm., Vulcan
1 hoist, 30-hp, single-drum, Vulcan.
3 compressors, Ingersoll-Rand 90B type 40; 75-hp, electric motor.
1 swing cutoff saw, 7½-hp.
1 timber saw, portable, electric, chain.
1 forklift, 3-ton Clark.
3 fans, axial-flow, 3-hp, Joy I-19.
1 fan, axial-flow, 5-hp, Joy I-21.
1 fan, axial-flow, model 21¼-17½-3450, 15-hp, Joy series 1000.
4 fans, axial-flow, model 25¼-17½-3450, 20-hp, Joy series 1000.
1 fan, axial-flow, model 38-26½-1750, 20-hp, Joy series 1000.
1 fan, axial-flow, model 21¼-17½-3450, 20-hp, 2-stage Joy series 1000.
2 pickup trucks, ½-ton.
1 panel truck, ½-ton.
1 water truck, 1½-ton.
1 ambulance, station-wagon.

TABLE 2, Wage Scale

Labor classification	Base rate per hour	Number of men employed Day shift	Night shift
Electrician, underground	$2.675	1	0
Mechanic, surface	2.575	1	0
Mechanic, underground	2.575	1	0
Hoistman, surface	2.575	1	1
Propman, underground	2.475	1	0
Cager, underground	2.375	1	1
Nipper, underground	2.275	1	0
General labor, underground	2.175	1	0
General labor, surface	2.175	1	0
General labor, surface	1.975	1	0
		10	2

TABLE 3, Stoping Contract Rates

Average height of ore, ft	Drill and blast, per cu ft	Slush and Iram, per cu ft	Props, move and set, each	Cribs, move and set, each	Equivalent rate per cu ft of advance
3½	$0.0875	$0.101	$5.42	$10.84	$0.334
4	.080	.0925	5.58	11.16	.303
4½	.073	.084	5.74	11.48	.279
5	.0675	.078	5.90	11.80	.256
5½	.0625	.0725	6.06	12.12	.238
6	.059	.068	6.23	12.46	.234
6½	.055	.064	6.40	12.80	.211
7	.053	.061	6.57	13.14	.202
7½ and over	.051	.058	6.74	13.48	.193

ing area. One two-man crew has blasted as many as 10 times in 8 hr in one longwall stope.

The cost to detonate a round with igniter cord is approximately 30% more than the cost of caps and safety fuse if the latter alone were used. In 1959 a 7-ft fuse complete with cap and connector, a prorated length of igniter cord, plus the labor to make up the fuse cost 14.64¢. The surety of ignition and firing sequence, plus safety at the low, muddy and often slippery faces are advantages of igniter cord. In 1959, dynamite consumption averaged 1.25 lb per hole, or 2.6 lb per dry ton of ore and waste at a cost of 48¢ per ton. Powder and primers together cost 79¢ per ton. Tons broken per hole averaged 0.48. The dynamite cost $18.30 per hundred lb, igniter cord cost $13.29 per 1000 ft and connectors cost $20.75 per 1000.

Scrapers convey the ore broken from the longwall faces downdip to the nearest drifts. During the blasting and scraping and the cleanup that follows, speed is stressed so that props and cribs can be moved up quickly to reduce the supported span from 12 to 8 ft. Two-drum, 20-hp, 440-v electric remote-controlled hoists pull 54-in., 1000-lb Cate scrapers. The bottom of the drift is from 2 to 3 ft below the bottom of the longwall face, an offset that provides storage on the track for the ore pulled downdip. To pull the scrapers, ½-in., 6x19, wire-center, Seale construction wire rope is used. The 54-in. scrapers travel 250 to 300 fpm through the 7 to 9-ft-wide aisle between face and lagging.

The scraper operator usually stands near the lagging where it crosses the strike drift. From there he can direct the scraper through his low-voltage remote-control, push-button stations. As the scraping distance increases and the operator is unable to see the muckpile clearly with his cap lamp, he is aided by lamp signals from his partner who stations himself on the other side of the tail sheave alongside the lagging.

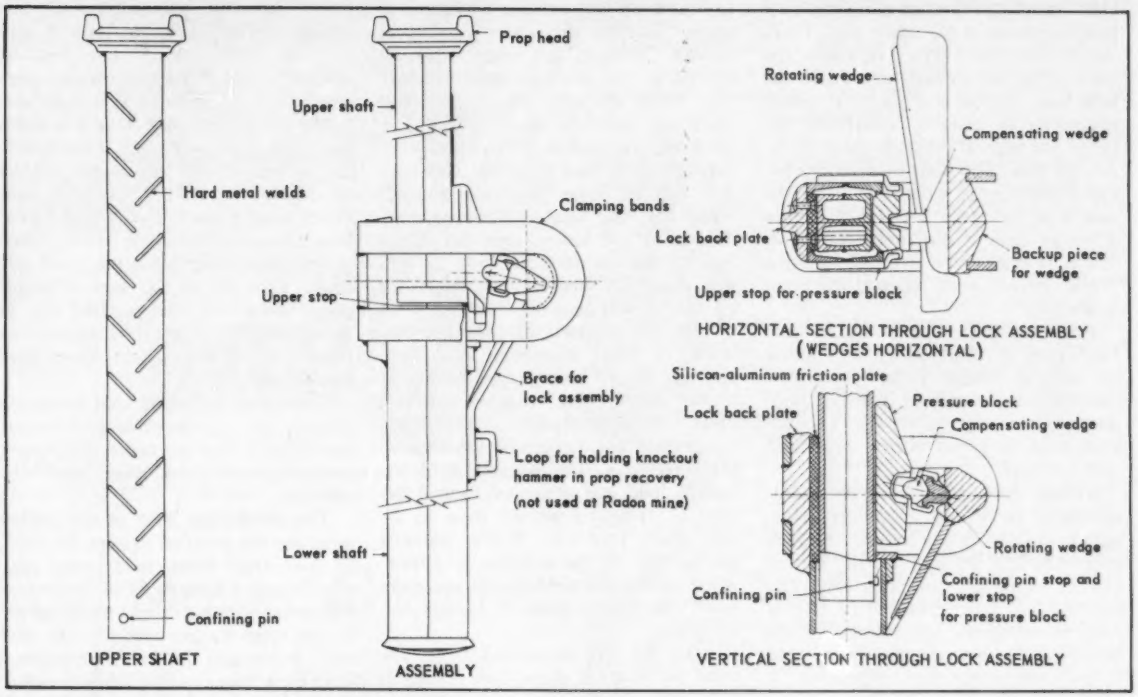
In the Far West stope, 20-hp, 3-drum slusher hoists are used to convey the ore directly to the raises. There, the 3-drum hoists are advantageous, because a number of faces are cleaned from one scraper setup.

To remove the lagging, the steel straps are cut with an axe.

Props Are String-Lined

Before any props are moved from the back row, a line is established 4 ft ahead of the front row by stretching a string between two tabular props temporarily set at both ends of the longwall. By aligning props carefully, lagging is made easier and better roof control is maintained; a straight break line helps to equalize prop load. Still keeping the back row intact, a few

(Continued on p 104)



The Becorit Prop—What It Is, How It Works

THE FIRST MODEL of the Becorit mine prop was developed in 1940-41 by the Becorit Mine Support Co. Ltd., Recklinghausen, Germany. The prop is made of three main parts: an upper shaft, a lower shaft, and a lock assembly. The upper shaft is made of two strong E-sections welded together to form a column that is about 2⅞-in. square. The middle bars on the E's butt to provide internal bracing to resist the pressure of the lock assembly. The upper shaft slides through the lock assembly, which is at the top and integral with the lower shaft, and telescopes into the hollow lower shaft, which is built of two 4-in. channels welded at their flanges. The four prongs on the top of the upper shaft were designed to hold a steel roof bar, but at the Radon mine they are used to hold a wood friction block. The base of the lower shaft, which rests on the ground, is convex. The lock assembly is a frictional device, which progressively tightens while the upper shaft moves downward ⅜ in. The principle feature of the lock is its rotating wedge, which when hammered tight into the assembly locks the two shafts together, and when hammered loose releases them. As the roof load increases, the additional wedging reaction increases the prop's resistance to the back load until the prop's maximum carrying load is reached.

The lock assembly is held together at the top of the lower shaft by two spring-steel clamping bands. The four-piece assembly consists of the backup piece, which is held within the curvature of the clamping bands, and which is itself a seat for the rotating wedge; the rotating wedge, which pivots within the backup piece; the compensating wedge, which is the link between the rotating wedge and the pressure block; and the movable pressure block; which fits against one side of the upper shaft. Fastened to the other side of the lower shaft to oppose the pressure of the pressure block is a silicon-aluminum friction plate. The friction plate is analogous to the stationary jaw of a clamp while the pressure block acts as the adjustable jaw. When the prop is being set, the rotating and compensating wedges are tilted upward at their maximum angle of approximately 12° with the horizontal so that the pressure block is at its highest position. When the prop is jacked to the setting load, the wedge is driven tightly into the lock with a hammer. Thin hard-metal welds on the pressure-block side of the upper shaft cut into the softer steel of the block and insures a gripping action. When the roof load exceeds the setting load, the pressure block moves downward with the upper shaft. The vertical movement of the block imparts a twisting motion to the rotating wedge because the rotating wedge can move only by pivoting downward about its axis in the seat of the backup piece. The downward travel of the block ceases when the block contacts its stop; the rotating and compensating wedges are then approximately 1° below the horizontal. As the friction shoe moves downward, the wedges act as if their combined width were being increased, and thereby place increasing stress on the spring-steel clamping bands. The bands are welded to the lock back plate and not to the sides of the prop, and their full elasticity is preserved. The full carrying load of the prop, rated at 40 to 50 tons, is reached when the upper shaft has traveled downward ⅜ in. As the weight of the roof surpasses the maximum carrying load, the prop yields although it is still exerting maximum resistance, and the upper shaft planes some metal from the pressure block. The upper shaft has a slight taper, about 1:300, throughout its length so that a continuous yielding resistance to the maximum load is achieved.

The extended height of the Becorit prop used at the Radon mine is 1.8 m or about 71 in. The collapsed height of the prop is 42 in. Without an extension, a prop weighs 153 lb. Extra heavy 4-in. pipe, which has a 0.337-in. wall thickness and a weight of 15 lb per ft, has been welded in 1, 2- and 3-ft lengths to the bottom of the props to reach higher backs. The 3-ft extensions have been found to be too long for good support. In 1956-57, 1400 Becorit props were purchased at a delivered cost of about $70 each. To minimize prop loss, a number is welded on each.

extra props are first set along the new line beginning at the updip end. Then, one by one and working downdip, the back props are shifted forward to the new line. Set on 3½ or 4-ft centers according to ground conditions, the props are aligned opposite those in the second row. The shift is diagonal because each prop, when moved to the new row, occupies a position farther downdip than it did in the old row. There is temporary overlap of three props opposite each other at the point of transfer.

Prop pulling is a two-man job. Each prop is collapsed by hammering its locking wedge loose. In a few cases where the ground is heavy, temporary support is gained with expendable wooden props during prop and crib removal.

Caving usually follows the withdrawal of each prop. Normally, it occurs gradually and by the time the last prop is pulled, the cave usually is broken all along the new back row. The back seldom falls immediately after a prop is collapsed, but when falls do occur the 20-hp slusher hoists are able to pull the props free. Moreover, a cantilever of rock will seldom overhang the last row. If an overhang fails to fall by the next day, cutoff holes are drilled, lightly charged, and shot to induce it to fall. The thicker sandstone lenses tend to overhang; mudstone and siltstone lenses break gradually and fall in small pieces.

The props are set in hitches that are easily chopped in the soft sandstone and mudstone bottom with an axe. After the lower shaft is set in the hitch, the upper shaft is telescoped vertically to the back. A 2½x3½x6-in. squeeze block, placed between the four prongs that protrude from the prop head, increases the friction between the back and the prop. The locking wedge is then tapped just tightly enough to hold the prop upright until set. A nearly uniform setting load is placed on each prop by hydraulically forcing the two telescoping shafts apart using a 10-ton ram. Because of this intitial compression, the prop better resists the initial downward movement of the back and is better able to withstand the jolts from the dynamite blasts that follow. Because of the unevenness and softness of the rock and the softness of the wood squeeze block, some yield probably occurs immediately after setting. The 10-ton initial load is sufficient to compensate for this yield.

Cribs Are Moved Each Time

Unlike the two rows of props that are leap-frogged one past the other as the face is advanced, the crib row is moved each time. The crib supports are centered between the two rows of props, and as the outer props are moved forward, the cribs must be moved as the shift progresses downdip. When the crib support is freed from the pressure of the back, the steel base is rolled and pulled 4 ft forward to its new position. This usually can be done by two men; occasionally, the slusher hoist is used. The cribs are spaced one for every four props on 14 and 16-ft centers depending on whether the props are on 3½ or 4-ft centers.

The crib supports are built of two units; A lower one-piece steel base and an upper multipiece hardwood timber crib. The timber cribbing blocks are piled on four steel crib releases that are bolted to the top of the steel base. The bases are 21 in. square, and are made of four 4-in., 13.6-lb, H-beams welded to a ½-in. base plate. Two 5-in., 6.7-lb channels tie the top of the columns together. All members are welded, and strengthened with braces made of ½ and ⅜-in. plate.

After the ore is hoisted from the mine in 50-cu-ft skips (see Table 1 for a list of principal mining equipment), it is transported 38 miles to the Uranium Reduction Co. mill in Moab by a contract trucker in 22-ton cable end-dump trucks or in 25-ton "pups," which consist of tandem-drive, end-dump trucks pulling four-wheel, end-dump trailers. The contract haulage cost in January 1960 was 4.7¢ a ton-mile.

Labor Costs at Radon

The Radon mine in 1959 produced 69,089 dry tons of ore, an average of 260 tpd. Productivity in 1959 for all underground labor and supervision, which included the forman and the two shifters, averaged 7.6 dry tons of ore per man-shift. For all labor and supervision at the mine, surface and underground, including the office and engineering staff, 5.6 dry tons of ore were produced per man-shift.

In 1959 the Radon mine operated two shifts a day, 5 days per week with an average of 45 to 48 employees, which included the whole mine force—labor and supervision—both underground and surface. In January 1960, 11 men were employed on day's pay wages, and 27 men worked under a contract-bonus system. The day's-pay men are listed in Table 2 according to their base hourly wage and the number employed per shift.

The work of the day's-pay propman has been important in the conservation of mine props. From October 1956, when stoping began, until December 1957, approximately 185 steel longwall props were lost; in 1958 when one man was assigned the task of caring for the props, only 7 were lost. In 1959 only 3 were lost. Of course, some early prop losses were the result of uncontrolled falls that broke across the prop lines, but many were lost because miners were unwilling to pull partly buried props clear of caved material. Before the mine crews were trained to care about prop loss, the propman often found "lost" props protruding from the cave material. His job is to have damaged props taken to the surface to be straightened, and cleaned and to deliver them to the stopes where they can be used again.

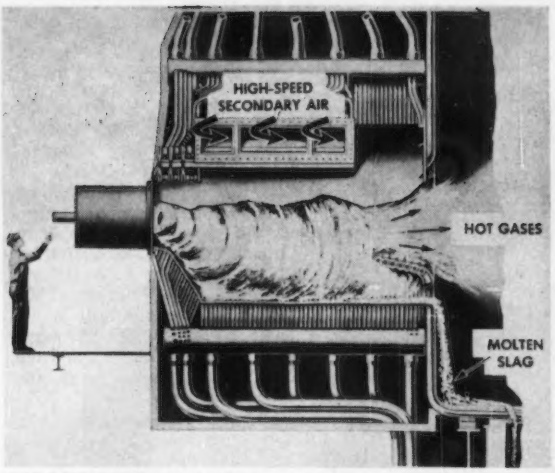
The supervisory and staff personnel include the superintendent, foreman, two shifters, two engineers, office man, warehouseman-timekeeper, and the sampler.

The production men at the Radon mine are the contract miners. In 1959, 27 men were being paid under contract-bonus schedules. The four stoping areas—the north and south stopes of the main Radon orebody, the Hot Rock stope, and the Far West stope—were each being worked by a separate contract crew. Except in the Hot Rock stope, where the crew worked only on day shift, each stope crew had its number split equally between the two shifts. The average 1959 contract earnings at the Radon mine were $39.36 per shift.

There are four contract-bonus rates for work completed in the stopes, based primarily on the heights of the stopes. Contract stoping rates that went into effect in March 1957 are shown in Table 3; the last column is for reader's interest only and is not a pay column.

Development contract-labor rates were based on lineal advance. Drifting, which included the labor to lay track and hang pipe, was paid for at the rate of $10 a lineal ft of advance. Inclines, or upgrade excavations, were paid at a rate of $8.50 a lineal ft for the first 100 ft of advance increased an additional 50¢ a ft for each added 50-ft interval. Declines, or down-grade excavations, were paid at the rate of $9.50 a ft for the first 50 ft of advance and increased an additional 50¢ a ft for each added 50-ft interval. The beginning rates paid for incline work were lower than those paid for drifting because in incline work the contractors were not required to lay track with the advance, and the rock could be moved quickly from the faces with scrapers. For greater distances, incline work was paid for at rates higher than those for drifting.

The labor cost in 1959 was $5.65 a ton. This includes all laborers, supervisors, engineers, clerical, and warehouse personnel at the mine.



DIRECT FIRING of pipeline coal slurry in Cyclone furnace was successfully demonstrated in New Jersey power station.

Coal Moves Ahead In Slurry Pumping

WHEN CONSOLIDATION COAL CO. (Consol) decided in 1949 to investigate coal transportation by pipeline instead of by railroad, it gambled that the pipeline system could keep Ohio coalfields competitive with more favorably located fields even though Consol was faced with inflation and spiralling transportation costs.

Eight years later, after testing pumping schemes in a $2-million pilot plant, Consol finished construction of a 10-in., 108-mile-long pipeline from Cadiz, Ohio, to Cleveland, Ohio. To date, approximately 5-million tons of coal have passed through this line, which last year operated 97½% of the total time.

Now Consol has teamed with Texas Eastern Transmission Co., Babcock & Wilcox Co. and Jersey Central Power & Light Co. to prove the feasibility of moving coal slurry to the large eastern market and burning the slurry directly without prior dewatering. Although the first trial shipments of the slurry were shipped by barge from Cleveland to Jersey Central's Werner Station in South Amboy, N.J., the combine hopes to line up enough customers to warrent building 20 to 30-in.-dia coal pipeline from the West Virginia coalfields to the eastern metropolitan markets.

More Solids Are Now Pumped

A major breakthrough in coal slurry transportation was made by Consol when it found it could increase the concentration of its slurry to 60% coal, 40% water from the original 50-50 coal-water mix through careful particle size control. For the Werner test, the slurry was further concentrated to 70-30 coal-water by simple decantation at the Cleveland storage tank.

According to Neil W. Eft, research engineer for Babcock & Wilcox, "coal slurry could become the cheapest source of heat energy." Babcock & Wilcox designed the Cyclone furnace shown above which burns 100% coal slurry. Although about 3% less efficient than a dry-coal furnace, the over-all energy costs are less because of the lower transportation cost of the pipeline and the simplified liquid handling system.

The implications are significant to the metals industry from two viewpoints: first as an energy consumer; second, like coal, as an industry faced with spiralling transportation costs and in need of cheaper haulage systems.

Although it took Consol years of research and a multimillion dollar pilot plant to prove a coal slurry pumping system was economic, long-distance slurry pumping technology as a whole hasn't been significantly advanced. It still takes pilot-plant trial-and-error techniques to design slurry pumping systems. Design formulas for incompressible liquids are not valid for slurries, and erosion and corrosion problems are extremely variable depending on the material transported. For example, South African designers found that, contrary to established belief, viscosity was far more important than specific gravity in determining pump horsepower requirements. (A 30-mile pipeline system handles uranium tailings in the republic.)

Although pipelines require a large capital investment, their operating and maintenance costs, where practical at all, are usually low. Therefore, their per-ton haulage costs are relatively stable over a long period of time. The metal and nonmetallic mining industry, with one eye on the future and the other eye looking at the record of rising haulage costs, is currently thinking hard about pipelines.

The Consol-CEI (Cleveland Electric Illuminating Co.) pipeline system consists of three major components: (1) the slurry preparation terminal at the Georgetown Preparation Plant of the Hanna Coal Division of Consol; (2) the 10-in. steel pipeline proper with pumping stations located in Georgetown, Carrollton and Atwater, Ohio, roughly 30 miles apart; and (3) the dewatering and drying terminal at CEI's Eastlake, Ohio power station.

At the preparation plant, coal fines and crushed minus-14-mesh raw coal are stored in separate tanks to prevent segregation of different size particles before they enter the line. Because the plant operates at 300 tph as opposed to the line's 150 tph, the tanks also provide storage capacity.

To insure the proper slurry concentration, the discharge from the drag tanks is processed in a mixer. At this point, automatic equipment continuously measures the mix and adds the proper amount of water.

Slurry Moves at Walking Speed

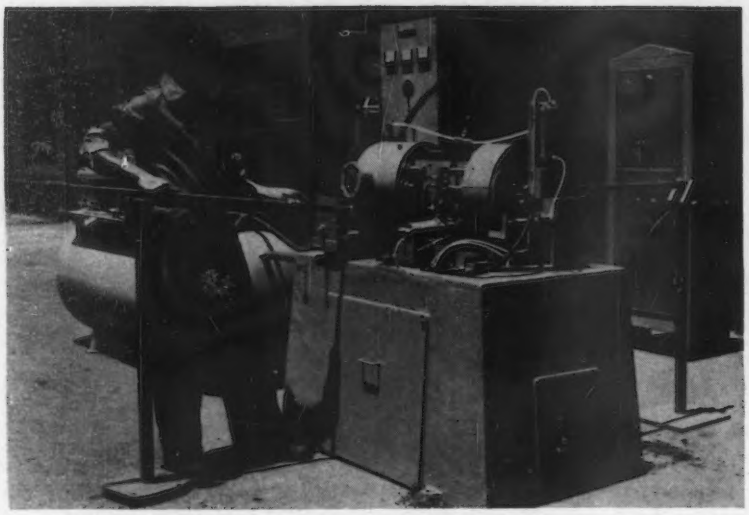
The slurry from the mixer is pumped to the initial pumping station. There are three pump units at each of the three locations. Each unit consists of a Wilson-Snyder reciprocating pump driven by a 450-hp squirrel-cage motor through hydraulic couplings and a speed reducer. Two pumps are capable of discharging the slurry, which moves about 3½ mph, at 1000 psig. The discharge from each pump goes into a single surge tank feeding directly into the pipeline.

The two booster pumping stations enroute are similar except for two reservoirs each, one for an emergency supply of water and the other for emergency dumping of slurry. Water is pumped from wells at each site.

There is a single pipe leading from each of the pumping plants. It is a 10¾-in. O.D. steel pipe wth all-welded joints. The wall thickness depends upon the location in relation to the pressure, which becomes lower as the flow proceeds through the pipeline. The thickness does not exceed 0.7 in. The entire pipeline is buried below the frost line some 4 to 5 ft under the surface.

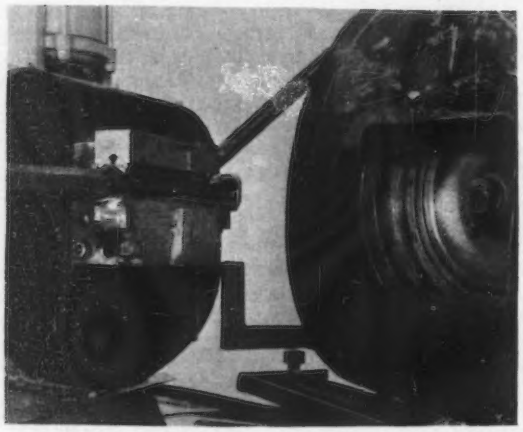
Because the coal is clean, very little wear occurs. Also, coal, like its gilsonite cousin, is greasy. After a short distance the corners of the particles become rounded, and wear decreases sharply. Nevertheless, 20 years of wear thickness was added to the thickness required for pressure and safety. Chemicals are added to combat corrosion.

OPERATING IDEAS



AUTOMATIC TIMER on electrolytic grinder disengages bit and grinding wheel at end of pre-set time, usually 30 seconds. The machine handles 100 to 150 bits per hour.

Automatic Grinder Speeds Resharpening Of TC Chisel Bits in South Africa



INTERNAL "VEE" of wheel is coated by a layer of diamonds nickel-plated to the surface.

ELECTROLYTIC RESHARPENING of tungsten carbide-tipped percussion bits has reduced service costs, increased speed of resharpening, and improved performance of bits at mining operations in South Africa.

The electrolytic machine employs a bronze grinding wheel with an internally nickel-plated "vee" shaped ring. The "vee" surface has one layer of diamond grit embedded in it. The diamond particles project from the surface of the "vee" between .001- and .003-in., acting as non-conductive spacers between the wheel and the bit chisel.

An electrolyte, consisting of potassium and sodium salts in water, is forced between the wheel and the chisel, causing a deplating of material from the carbide tip. The diamonds, in addition to accurately controlling the size of the gap, also act as scrapers and remove any material which has not been deplated completely.

Operation Is Automatic

Once the percussion bit is placed in position and the machine is activated, it automatically clamps the bit, engages it with the wheel, grinds for a pre-set time, disengages the wheel and bit, and unclamps the bit for removal.

Grinding time is usually set at between 20 and 30 seconds, though this figure is controlled by the average degree of bluntness of bits. A bit that has been overdrilled and is very blunt requires two grinding cycles. It is more economical to set the time cycle of the grinding operation to service bits which have done the least work and then grind unusually blunt bits for two and even three cycles if necessary.

In the low-voltage electrical circuit for the electrolytic process, the drill is the anode and a current of 400 to 500 amps at 6 to 8 v is passed between it and the metal wheel which also acts as the cathode.

Grinding Is Continuous

Each machine is constructed with two diamond wheels so that when one end is being unloaded and reloaded, the other end is grinding a percussion bit. One man can handle each machine. When it is set at a grinding cycle of 30 seconds, from 100 to 150 stems can be ground per hr per machine.

The main advantage of this type of grinding is the smooth surface finish which is achieved, increasing the service life of the bits. The stock removed is fine powder in micron sizes and can be filtered to keep electrolyte fluid as free of solids as possible.

The presence of the sludge in the electrolyte is not detrimental to the action and tends to act as a lapping compound changing the normal matte finish to a mirror finish.

The formed wheels operate at a speed of approximately 6000 surface fpm. The "vee" of the wheel incorporates a small radius at the apex, eliminating the necessity for honing which is required when resharpening the bits with conventional wheels.

Drill Life Increased

In comparing bits ground in the electrolytic machine with those ground by conventional wheels, an improvement in drill life of between 5 and 10% has been shown.

The wheel life of the diamond-coated electrolytic wheels has been extremely high. On machines set for 30-sec regrinds, from 40,000 to 100,000 bits can be resharpened with each wheel.

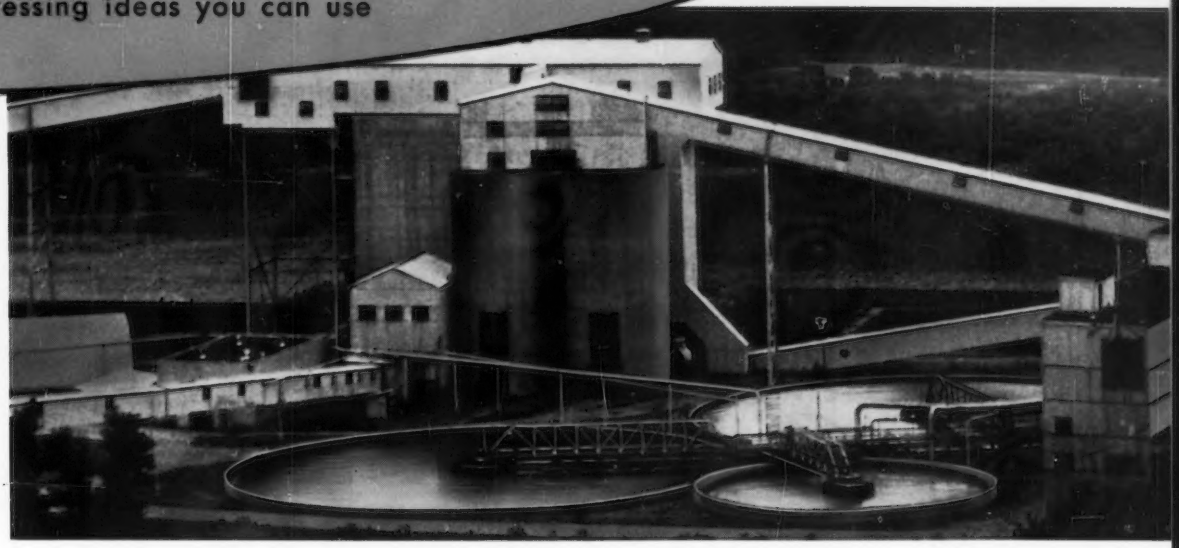
A problem was encountered in electroplating the diamonds to the internal "vee" of the electrolytic wheel. The ⅛-in.-thick nickel plating was found to be either too brittle at required hardness or too soft when stress free. Diamond Research Laboratory in Johannesburg worked on a newly developed plating bath which now produces nickel platings of ⅛-inch thickness which have the hardness of spring steel and are free of stresses.

A technical paper explaining all aspects of this economical method for resharpening chisel-shaped percussion bits can be obtained by writing to Mr. J. L. Glassford, Hard Metals Ltd., Springs, Republic of South Africa.

CYANAMID

Reagent News

ore-dressing ideas you can use



From Coal Refuse to Precious Metal Slimes!

Cyanamid AEROFLOC® 550 Reagent speeds up settling, improves filtration and adds operating flexibility

Addition of low cost AEROFLOC 550 Reagent to the refuse thickener of this modern coal preparation plant increased the settling rate of refuse solids to approximately 10 feet per hour and reduced overflow solids content to less than 200 ppm.

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	Without AEROFLOC 550	**With AEROFLOC 550**
Coal Filters	71.6	97.6
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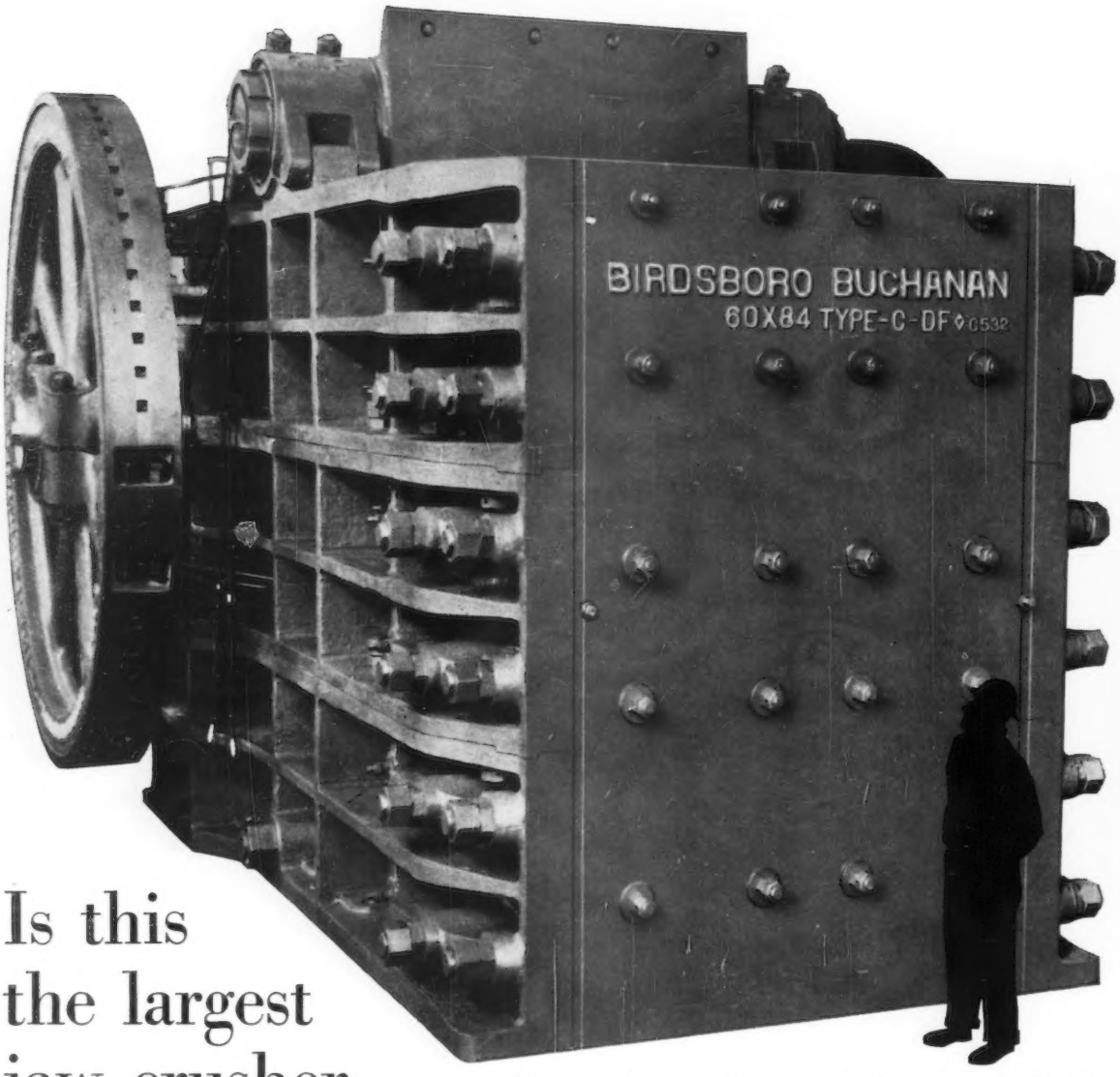
Film Forming Agents • Surface Active Agents

* * * * *

High Explosives • Permissibles
Seismograph Explosives
Blasting Agents • Blasting Caps
Electric Blasting Caps • Blasting Accessories



Is this the largest jaw crusher in Chile?

Ready to reduce up to 880 tons of iron ore per hour, this new Birdsboro-Buchanan deep frame jaw crusher is believed to be the largest ever sent to Chile. Weighing over half a million pounds, the huge 60″ x 84″ Type-C-DF crusher will reduce five-foot lumps of iron ore to eight-inch size.

This crusher is one of many of similar design and size built by Birdsboro Corporation in recent years. To tap this valuable manufacturing experience, let Birdsboro build your next crusher. For details, write: *Sales Department, Engineering Department & Mfg. Plant:* Birdsboro, Pa., *District Office:* Pittsburgh, Pa.

Canadian Representative & Manufacturer: John Inglis Co., Ltd., Toronto, Canada.

World-Wide Agent Representation. Contact home office for nearest representative.

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DIVISIONS: **MIRAWAL DIVISION • CHEMICAL MACHINERY DIVISION**

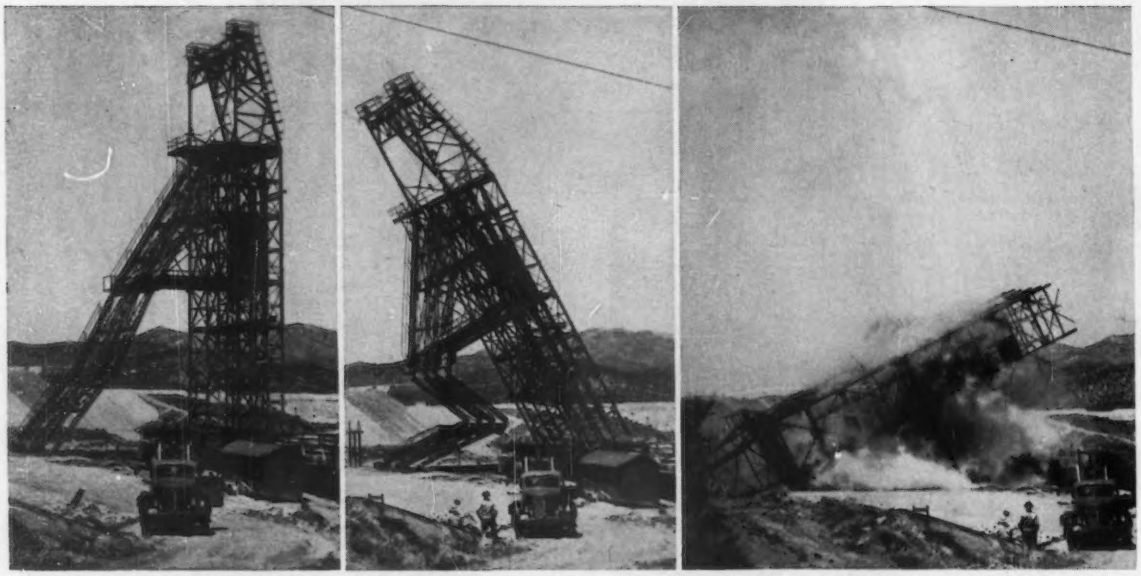
THESE CABLES ARE PRICED THE SAME ...BUT ONE CAN SAVE YOU MONEY!

The special high visibility color jacket you see on the Phelps Dodge TUFPLY portable cable is not just decoration. It has a practical dollars-and-cents value. Developed for use in Phelps Dodge open pit mines, this brightly colored jacket has established records for lengthening cable life.

How? By making the cable clearly visible to operators of trucks and other equipment, needless on-the-job damage is avoided and cable life is extended. If cable damage by careless operators is your problem, call your Phelps Dodge representative today.

PHELPS DODGE COPPER PRODUCTS
CORPORATION • 300 PARK AVENUE, NEW YORK 22, N. Y.

THE "STAND OUT" JACKET MAKES CABLE "STAND UP" LONGER!



DOWN SHE GOES! With lumberjack precision, the 100-ft-high steel headframe falls within 2 ft of the calculated area.

How Kennecott Razed Star Pointer Headframe Without Blasting

THE MANAGEMENT of Kennecott Copper Corp., Nevada Mines Division, McGill, Nevada, was recently confronted with the task of safely razing at reasonable cost the 100-ft steel headframe at the Star Pointer shaft which for many years served the underground mining area at Ruth. Careful study of the problem revealed that the headframe could be toppled within a limited area without use of explosives. This was accomplished by first removing the shaft house enclosure, several support girders, and sheave wheels. Next, the front leg braces were cut at three points and the rear compression members severed, after which the entire structure collapsed, falling within 2 ft of the calculated area. The job was carried out under contract by Robert J. Birch. All steel salvaged was transported to the reduction plant foundry at McGill.

Hydraulic Monitor Speeds Cleaning Smelter Reservoir

A TASK PERIODICALLY PERFORMED at the smelter of Kennecott Copper Corp., Nevada Mines Division, McGill, Nevada, is skimming off settlings in the reservoir above the smelter receiving a part of final concentrator tailings for subsequent use in granulating reverberatory furnace slag. The solids carried by the tailings will settle in the bottom of the reservoir and eventually will block the discharge opening.

When done with fire hose and shovel, some 16 hours of reverberatory helper time are required to clean the reservoir bottom. This was reduced to only four hours of work a week after installation of a hydraulic monitor operated by one man.

The change made was suggested by a group of smelter employees whose chairman was E. Pesout, smelter operations superintendent.

Cost of the monitor, including installation was $128.00 and annual savings are estimated at more than $1434.00.

25% additional service with Yellow Strand "POWERSTEEL" at Watauga Stone Co.

"Rugged" is the only way to describe the job of digging rough shot rock out of this Tennessee quarry. It takes rugged equipment to match the job and for this reason, Watauga Stone Co., Carter County, Tennessee, specifies Yellow Strand "POWERSTEEL" Wire Rope.

Hoist and crowd lines take quite a beating—they used to last 3 weeks on this big 2½ yd. shovel. Three years ago Watauga tried—and liked—Yellow Strand "POWERSTEEL" Wire Rope. They found Yellow Strand "POWERSTEEL" runs an average of 4 weeks—6 days per week, 8-hour shifts—between hoist and crowd rope changes. They report, "We're more than satisfied with Yellow Strand "POWERSTEEL."

25% longer life is an excellent average. B & B's extra high strength rope is designed for heavy loads and abrasive conditions. It's available right now from your Yellow Strand Distributor. Call him! *Broderick & Bascom Rope Co., 4203 Union Blvd., St. Louis 15, Mo.*

Yellow Strand®
"POWERSTEEL"®
WIRE ROPE

PERSONALS

Lindquist

Gold

Carl G. Lindquist has been named assistant director and **Dr. Louis Gold,** staff scientist, for the Kennecott Copper Corp.'s Basic Research Laboratory at Lexington, Mass.

Facilities for Kennecott's new lab, now in the early stages of organization, are expected to be ready in late 1962. The lab will engage in basic research with emphasis on the fundamental structure and properties of materials.

Lindquist comes to Kennecott following a temporary assignment with the Polaroid Corp. He was associated with the Knolls Atomic Power Laboratory from 1955 to 1960. Prior to that, he was associate professor of chemical engineering at Stanford University.

Gold was visiting professor at the University of Michigan during the past year, and in 1958-59, was a guest scientist at Princeton University. Gold's affiliation with Kennecott's new basic research lab brings him back to Boston where he was once a staff member at the M.I.T. Lincoln Laboratories. During the past two years he has been engaged in research concerning the relation of plasma physics to electronic phenomena in solids.

Borcherdt & Smith has announced that after November 15, its western office will be located at 520 East Fourth Street, Salt Lake City 2, Utah.

Thomas E. Rowlands has been named president and **J. W. Strath,** executive vice president, of Canadian Aero Service Ltd., Ottawa, worldwide aerial mapping company.

Rowlands joined the company in 1951 as chief of its electronics division. He directed pioneering exploration and mapping surveys in the Far North, and in recent years, he has been responsible for the overseas survey operations of Canadian Aero Service. In 1959, he became vice president, engineering and operations.

Strath has been associated with Canadian Aero since 1954. His early experience with the company was in flight operations. His firsthand knowledge of survey operations proved invaluable in his later assignment to sales functions. In 1959, he was named vice president, sales. He will continue his sales responsibilities in his new post. Strath recently made an extended tour overseas to present the company's resources inventory and development services to governments and industries abroad.

J. C. Keiffer, manager of the Northwestern Mining Department of the American Smelting and Refining Company at Wallace, is the new president of the Idaho Mining Association, which has gone on record against federal government entry into the field of mines safety inspections. **George McHough,** Boise, manager of mines of the J. R. Simplot Co., and **Harry W. Marsh,** Boise, were named vice presidents and **A. J. Teske,** Boise, secretary-treasurer.

George Deneris, industrial engineer at Garfield electrolytic refinery, Utah Copper Division, Kennecott Copper Corp., has been named maintenance superintendent at Garfield, Utah, smelter. He succeeds **William B. York** who recently resigned to join Cellotex Corp.

Deneris, a graduate of University of Utah, has been with Utah Copper since 1948 and in industrial engineering since 1956.

Daniel J. Smith, Pittsburgh, has been elected president of the Duluth, Mesabi & Iron Range Ry. to succeed **Fred J. Voss,** Duluth, who died in July.

Earle F. Young, Jr., Pittsburgh, Pa., has been appointed supervisor of ore research for Jones & Laughlin Steel Corp.

R. W. Maki, mining engineer at Jones & Laughlin's Tracy underground mine, Negaunee, Mich., has been transferred to the company's Mesabi range office in Virginia.

Douglas Tippett, Ishpeming, mining captain at Inland Steel Company's Morris underground mine until it was permanently closed recently, is now at Inland's Sherwood underground mine at Iron River, Mich., as shift boss.

Raymond H. Feierabend has been elected a vice president of Freeport Sulphur Co. He will be responsible for the company's sulphur operations in Louisiana which includes five mines currently producing at a rate in excess of 2-million tons per year.

Feierabend

A graduate of the Columbia School of Mines, Feierabend joined Freeport in 1942 and served as superintendent of the company's largest mine, Grande Ecaille, La., from 1953 to 1956. In 1957, he was named assistant vice president and placed in charge of the development of Grand Isle, the world's largest offshore sulphur project, located seven miles out in the Gulf of Mexico.

Feierabend is a member of the board of the American Institute of Mining, Metallurgical and Petroleum Engineers, of the Society of Mining Engineers of the AIME, and of the Delta section of the group. He is also a member of the Mining and Metallurgical Society of America.

William C. Osborne has been appointed vice president in charge of engineering and research for Research - Cottrell, Inc., Bound Brook, N.J. At the same time, Osborne was made a director of the corporation. He will have complete responsibility for all engineering and research activities.

Osborne

Osborne was graduated from Rensselaer Polytechnic Institute in 1942 with a degree in mechanical engineering. He also holds a Master of Science degree from Princeton University.

Osborne was research associate at the California Institute of Technology, where for several years he studied and conducted basic research programs in the field of hydrodynamics.

Prior to joining Research-Cottrell Osborne was manager of engineering of the Harrison Division of Worthington Corp.

He is a member of the Professional Engineers Society.

Dr. Joseph L. Gillson has been appointed consultant for the engineering and construction division of Southwestern Engineering Company. As consultant for the process department, Gillson's work in mining and chemical processes will be particularly concerned with the treatment of titanium ore for recovery of titanium oxide.

Dr. Gillson is well known in the mining and chemical field. In 1960 he was president of AIME; he is a past president of the Society of Economic Geologists and of the American Geological Institute; a past vice president of the Mineralogical Society of America; and a Fellow of the Geological Society of America. He received his Doctorate of Science from Massachusetts Institute of Technology in 1923. He has taught at Harvard University and at MIT and was chief geologist with E. I. Du Pont de Nemours Company.

John H. Melvin, formerly general manager of the Pennsylvania Drilling Company, and onetime state geologist of Ohio, has assumed practice as a consulting geologist with headquarters in Pittsburgh.

Walter P. Huhn, Jr., has been appointed manager of metallurgical services for American Potash & Chemical Corp.

Huhn, who will make his headquarters in Industry, Pa., formerly was a senior melting metallurgist with Crucible Steel. He is a 1950 graduate of Carnegie Institute of Technology.

American Potash has a multi-million dollar electrolytic manganese metal plant under construction at its Aberdeen, Miss., operation. It is scheduled to go on stream early in the first quarter of 1962.

(Continued on p 114.)

YOUR

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BECOMES

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The plant that will effectively and economically implement your chemical or metallurgical process is one designed, engineered, erected, equipped and tested by Stearns-Roger engineers. Our service can save you months of lost time getting into production and avoiding trial and error in bringing operations up to design capacity. For over half a century Stearns-Roger plants have been known as the best that the technical skills can produce. When you begin to plan facilities, consult Stearns-Roger.

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ENGINEERS • CONSTRUCTORS
MANUFACTURERS

PERSONALS *(Continued)*

Lloyd E. Elkins, of Tulsa, has been elected president of the American Institute of Mining, Metallurgical and Petroleum Engineers for 1962. He will take office February 20 during the 91st Annual Meeting of the Institute to be held in New York.

Elkins will succeed **Ronald R. McNaughton,** of Trail, B.C., the first Canadian citizen to head the Institute. Elkins is production research director for Pan American Petroleum Corp. He has held important posts in the AIME and in its Society of Petroleum Engineers, which nominated him for the AIME presidency. Elkins is a Colorado School of Mines graduate.

Roger V. Pierce, consulting engineer of Salt Lake City, has been named president-elect of the AIME, 1962, pointing to the presidency in 1963 in succession to Elkins.

Among the others elected to AIME posts were: **James C. Gray** of Pittsburgh, to be vice president. He is now president of the Society of Mining Engineers of AIME. He is administrative vice president, raw materials, U.S. Steel Corp.

Carleton C. Long, of Monaca, Pa., to be vice president for a second term. Long, a former president of the Metallurgical Society of the AIME, is director of research, zinc smelting division, St. Joseph Lead Co.

William B. Stephenson, of Paoli, Pa., to be vice president. He will also become president of the Society of Mining Engineers of the AIME. He is president of the Allen-Sherman-Hoff Pump Co.

Norman L. Weiss, of Tucson, Ariz., to be a director of AIME. He is milling engineer, southwest mining dept., American Smelting and Refining Co.

Garvin L. Augustadt, formerly general superintendent of Magma Copper Co.'s operations at Superior, Ariz., is now general manager of both the Superior operations and the Magma Arizona Railroad, succeeding **Darrell Gardner.**

Hubert J. Steele, formerly assistant mine superintendent, is now general superintendent of the Superior operations, and **Walter W. Chafey,** formerly division foreman, is now general mine foreman.

Mitchell Melich, of Moab, Utah, president of Uranium Reduction Co., and secretary of Utex Exploration Co., has been named Republican National Committeeman for Utah.

Melich, in addition to his mining activities, is a practicing lawyer in Moab. He was graduated from the University of Utah, and is now serving on the University's Board of Regents. He is a member of the Utah State Bar and the Republican State Central Committee. He has served as Republican county chairman of Grand County and in other GOP positions.

From 1940 to 1948, Melich represented Grand, San Juan and Emery Counties in the Utah State Senate.

Donald G. Ashe, sales manager of The Allen-Sherman-Hoff Pump Co., Paoli, Pa., is now a vice president of the company. Joining the company as sales engineer in 1954, he has been head of sales engineering since 1959.

Ashe

A son of an engineer with The Anaconda Company, Mr. Ashe was born in Chuquicamata, Chile. Moving with his father into other mining areas, he received his high school education in Buenos Aires, Argentina, and in Bisbee, Arizona.

In 1950 he was graduated with the degree of Metallurgical Engineer from The Colorado School of Mines, where he was a member of Theta Tau Engineering Fraternity and Sigma Alpha Epsilon Fraternity. It was after four years as concentrator metallurgist with The Cananea Consolidated Copper Company, S.A., at Cananea, Sonora, Mexico, that he assumed activity with the A-S-H Hydroseal and Centriseal rubber-lined pumps, known throughout the world for moving abrasive and corrosive materials in mines and processing plants.

As a member of the American Institute of Mining, Metallurgical and Petroleum Engineers, Inc., Mr. Ashe has served as chairman of the "Materials Handling" Technical committee for the Minerals Beneficiation division.

OBITUARIES

Lt.-Col. Norman F. Parkinson died recently at his home in Victoria, B.C., where he had been living in retirement.

He had been secretary-treasurer of the Falconbridge Nickel Mines from the founding of the company until 1943. During this period he lay down a program whereby greater use was made of nickel alloys through the Fahralloy Co. Parkinson also worked on the original Sherritt-Gordon mine development in Manitoba.

He was executive director of the Ontario Mining Association from 1945-57.

George W. Dunn, 59, superintendent of The Bunker Hill Co.'s lead smelter at Kellogg, Idaho, died October 25 following prolonged illness.

Dunn joined Bunker Hill as a metallurgist in 1929 following his graduation from the University of Idaho. He later became a department superintendent at the smelter, and was promoted to plant superintendent in 1955.

J. E. Berg, 71, long prominent in the mining and civic life of the Coeur d'Alenes of Idaho and a retired former northwestern mining department manager of the American Smelting and Refining Co., died August 9, in Olympia, Wash.

Berg was born in Ishpeming, Mich., received a degree in mining engineering from the University of Washington in 1914, and came to north Idaho in 1918 after four years as an engineer in Alaska. His first work in north Idaho was as an engineer and geologist with the Day mining interests. From there, in 1923, he went to Federal Mining and Smelting Co., predecessor of the American Smelting and Refining Co., with whom he rose to northwestern mining department manager after progressing through various important positions.

Berg is credited with playing a major role in bringing in two of the Coeur d'Alene district's major producers—the Page mine west of Kellogg, and the Galena at the west doorstep of Wallace. The Asarco Van Stone mine in Washington was also acquired during his tenure as general manager.

Berg was a former officer and prominent member of the Idaho Mining Association. He had also been active for many years in the affairs of the Northwest Mining Assn. and the American Mining Congress.

H. E. T. Haultain, 92, professor emeritus of mining engineering at the University of Toronto, died last September. He had never officially retired, and was still actively directing his business affairs. Affectionately known to generations of students as "The Old Man", Haultain had a long and varied career, of which teaching was only one facet.

He was graduated from the University of Toronto in 1889, three years before the course in mining engineering was established. In 1900, he was awarded the degree of civil engineer, but by then he had done post graduate work in London and in Freiberg, Germany. His mining experience included jobs in Ireland, Bohemia, South Africa, British Columbia, the western U.S. and Ontario.

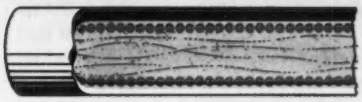
In 1908, Haultain was appointed professor of mining engineering at the University of Toronto, a position he held for 30 years. He was the originator of the Kipling Ritual, a ceremony at which all Canadian engineering graduates are sworn to uphold the standards of their profession.

Although he retired from teaching in 1938, Haultain continued to pursue his research work in the space that was allotted to him in the University's Mill Building. Ore dressing was his life's work, and he had a number of inventions to his credit. He made notable studies on grinding, but perhaps his greatest accomplishment lay in developing the superpanner and the infrasizer. Both of these were instruments for separating materials in extremely fine sizes. With the superpanner, Haultain proved that tellurides were soluble in cyanide.

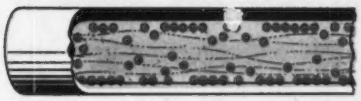
Haultain was a member of the Association of Professional Engineers of Ontario, and its president in 1925. He was also a member of the Technical Service Council which was formed for the purpose of keeping engineers in Canada.

LUBE LOGIC

Tips for more efficient equipment performance



Rust inhibited oil protects by "plating" metal surfaces with additive shield.



Adding straight mineral oil disturbs this plating effect.

For best rust protection, don't mix straight mineral oil with additive-type hydraulic oil

When you find it's time to add makeup oil to a hydraulic system filled with rust-inhibited oil, make sure you don't use straight mineral oil as makeup.

Reason why: the rust inhibitors in a fortified oil, such as Regal Oil R&O, prevent rusting by "plating out" on metal surfaces, sealing them against air and moisture. The presence of this film depends on a chemical equilibrium in the oil, and it will give optimum protection only as long as this equilibrium is maintained. If you add straight mineral oil after an original charge of rust-inhibited oil, you'll disturb this chemical balance, and some of the "plated out" inhibitors will go back into the oil. How much "plating" you lose depends on how much straight mineral oil you add, of course, but even a tiny bit of rust can scratch precision pump parts like gravel. So, don't take chances; stick to rust-inhibited oil in your hydraulic systems.

Location of automatic air line oiler determines how well it works

Automatic air line oilers work best when they're located not more than ten feet from the air tool they're lubricating. Some operators put the oiler right at the end of the air pipeline, with up to 50 feet of hose between the oiler and the air tool. That's *not* the way to do it. Automatic oilers operate by spraying a fine oil mist into the air stream. The air will carry the oil just so far, and then the oil begins to hang up inside the hose. The drill gets only a fraction of the oil going into the system, so you use a lot of oil and still get inadequate lubrication.

With only ten feet of hose between the oiler and the drill, the oil can atomize properly but hasn't a chance to hang up inside the hose. Thus you lubricate the drill thoroughly, and use far less oil in the long run.

1. PLAN FOR PROFIT — Texaco's newest color-and-sound movie. Dramatizes the major savings you can make with the proper investment of less than 1% of your total budget — the amount you spend on lubricants. Film features latest lubrication methods and equipment on a number of actual locations, demonstrating the Texaco Simplified Lubrication Plan in action.

2. FUNDAMENTALS OF LUBRICATION — a brand new Texaco color slide film. A clear, concise once-over that defines technical terms like "viscosity" and explains specifically what lubrication is and what it does. This down-to-earth discussion will give the lubrication man a new understanding of the importance of lubrication, and a fresh interest in his work. It's supplemented with a manual that covers the same ground in greater detail.

3. LUBRICATION OF EARTHMOVING EQUIPMENT — a new slide film, in color. A concise, easy-to-understand analysis of proper lubrication of engines, wheel bearings, steering, track rollers, crawler treads, hydraulic equipment, wire rope, open and enclosed gears. Supplemented with a manual that covers the whole field of earthmoving equipment lubrication in further detail.

FOR AN EARLY SHOWING of any one of these films — or all of them — contact your Texaco Representative *now*.

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Every month or so we'll bring you a batch of "sleepers," little angles, so easy to overlook, where big savings in time and money can be made. If Lube Logic doesn't solve your problems, call your local Texaco man. Anytime, all the time, he's your best source of money-saving lubrication ideas. Don't forget that "Lubrication is a major factor in cost control." Texaco Inc., 135 East 42nd Street, New York 17, N. Y.

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TEXACO

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process and the building of a larger test plant with units of the size thought suitable for the final mill installation. This test plant ran through the whole of the past year. Experiments were conducted to determine the best grinding machines, as well as the necessary fineness of the grinding for best results. Parallel tests were run on various flowsheets and on five different flotation machines. Systematic investigation, both in actual practice and in the laboratory, was made of various flotation oils.

During the first months of the year our flotation efforts met with varying fortune. Beginning August 1, we put into effect a flowsheet in the main like that finally adopted for our mill construction and in use a frothing agent selected through laboratory tests by those in charge of our experimental work. To date, the saving of copper occuring in the ore in sulphide form has averaged 86.7%, and during the past month has averaged 90.3%.

1916. Mr. Mills included the following mill statistics for the six months operation, from July to December, 1915, inclusive, as follows:

"The tons of ore concentrated for the six months were 778,851.

Assay of ore milled	1.702
Oxide copper in ore	226
Assay of tailings	.373
Oxide copper in tailings	.18
Assay of concentrates from flotation	37.63
Assay of concentrates from tables	13.12
Average assay of concentrates — Total made	32.67
Average recovery of total copper in ores milled	79.95
Average recovery on sulphide copper in ores milled	88.56

24.6 tons of ore were required to produce one ton of concentrates."

Unusual Applications and Blue-Sky Possibilities

Flotation in other media. Gaudin suggested recently that flotation of materials in media other than water (or brines) offered interesting possibilities. While observing the blowing of air through molten tin in a refinery, he noted, for example, that certain particles attached themselves to the bubbles and rose to the top of the melt, just as they do in conventional froth flotation.

A shift in flotation's position. "I do feel that we are going to find that flotation can move out of its customary place in the flowsheet. Normally, we think of comminution, flotation, roasting, smelting and refining. The success experienced by Inco in separating copper and nickel sulphides from slowly-cooled matter is one example of what I mean. Flotation may follow roasting or smelting or be capable of achieving separations or purifications not to be obtained in any other way." *Professor of Metallurgy.*

In our sights. "We look hopefully for developing advances in the following areas:

1. More specific selective sulphide promoters.
2. Techniques and reagents which make possible the successful treatment of ore fractions which we now refer to as slimes.
3. Ion flotation.
4. Improved techniques for the separation of copper-molybdenum sulphides."

Manager, reagent manufacturing division.

What we have to learn. "Flotation is just a tool—not an end unto itself. By this I suggest that the flotation engineer must learn to use other tools to achieve flotation progress and applicability. He must in the future use chemical engineering, hydro- and pyro-metallurgy and other processes to augment and improve flotation processing. The Leach-Precipitation-Flotation process for the treatment of oxidized copper is a good example of what can be accomplished in this respect. The moly-by-product field is another place where the dissolution of low-grade mineral flotation products with ultimate upgrading of pregnant solutions and the use of selective ion exchange processes can be used for the extraction of one or more valuable metals. These metals in soluble form can be precipitated directly into marketable products." *Metallurgist, copper mining company.*

Blue-sky forecasts. I expect to see completely automated flotation plants within ten years. These plants will be computer-controlled and use activation analysis and other new techniques to continuously assay and feed pulp and tailings. Feed rates, reagent additions and all variables will be automatically controlled. For example, if the tailing assay increases a hundredth of one percent, the computer will check the feed analyses and determine if the loss can be reduced. If feed analysis shows that the loss is due to say copper oxide, which does not float readily, no adjustment would be made. The continuous analysis system will recognize mineralogical changes as well as chemical changes. The degree of aeration will be continually recorded along with pulp temperature, water hardness and many variables not even measured in today's plants. I would also forecast that new flotation cell design will trend toward simplification, less waste of power, more control of aeration, and cells designed with automation in mind.

Head of mineral processing division major mining company

Conditioning—Key to future progress. "I feel that all minerals will float if properly conditioned—the real problem is to find these conditions. Hence conditioning agents are the field in which most work will probably be done in the future. If conditioning agents do not solve the problem, then prior ore treatment to change the physical condition of the ore must do the job. Maybe the ore will be heated dry to bring about these changes, then put into a pulp to float away the desired minerals. Maybe prior treatment will be roasting, steaming, gassing, charging statically, or some other type of treatment."

Ore dressing engineer

What to look for. "All flotation practice will be introduced into the coal industry just as it has been done in the metallic field. All flotation practice will increase in the treatment of iron ores. Even where magnetite is involved and magnetic separation is used, flotation will be used to retreat magnetic separation concentrates. In the field of hydrometallurgy, where ion exchange will apply, look for recovery of resin-in-pulp by flotation methods."

Metallurgical field engineer

An Area for a Breakthrough New Geological Targets? . . .

"The question arises as to what conceivable advances in flotation may we hope to see in the next decade or so? I do not think any further advance is required. We have all the controls necessary for efficient work —capital expenditure will limit the full utilization of such controls. But

(*Continued on p 120*)

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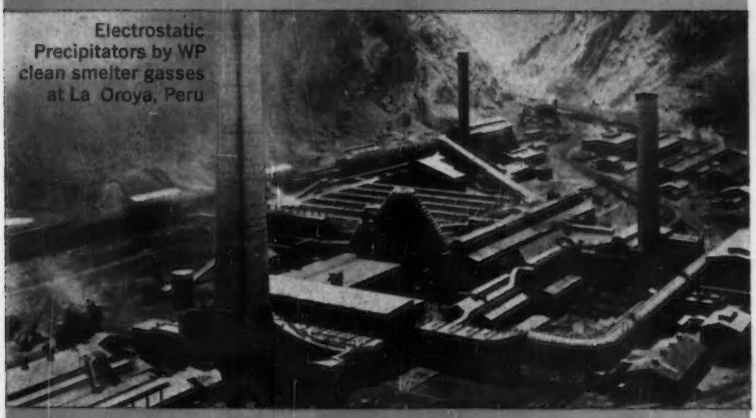
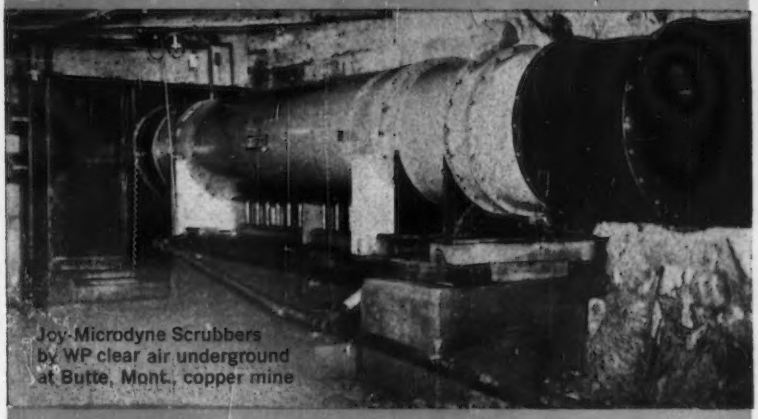
WILLIAMS • WINDOLPH • WINKLER • WOOD • WORTHINGTON • WRAITH • WROBEL • YINGST • YOUNG • ZEIGLER • ZEUCH • ZIMMERLEY



Electrostatic Precipitators by WP clean smelter gasses at La Oroya, Peru

Copper smelters in Peru... and miners in Montana...agree:



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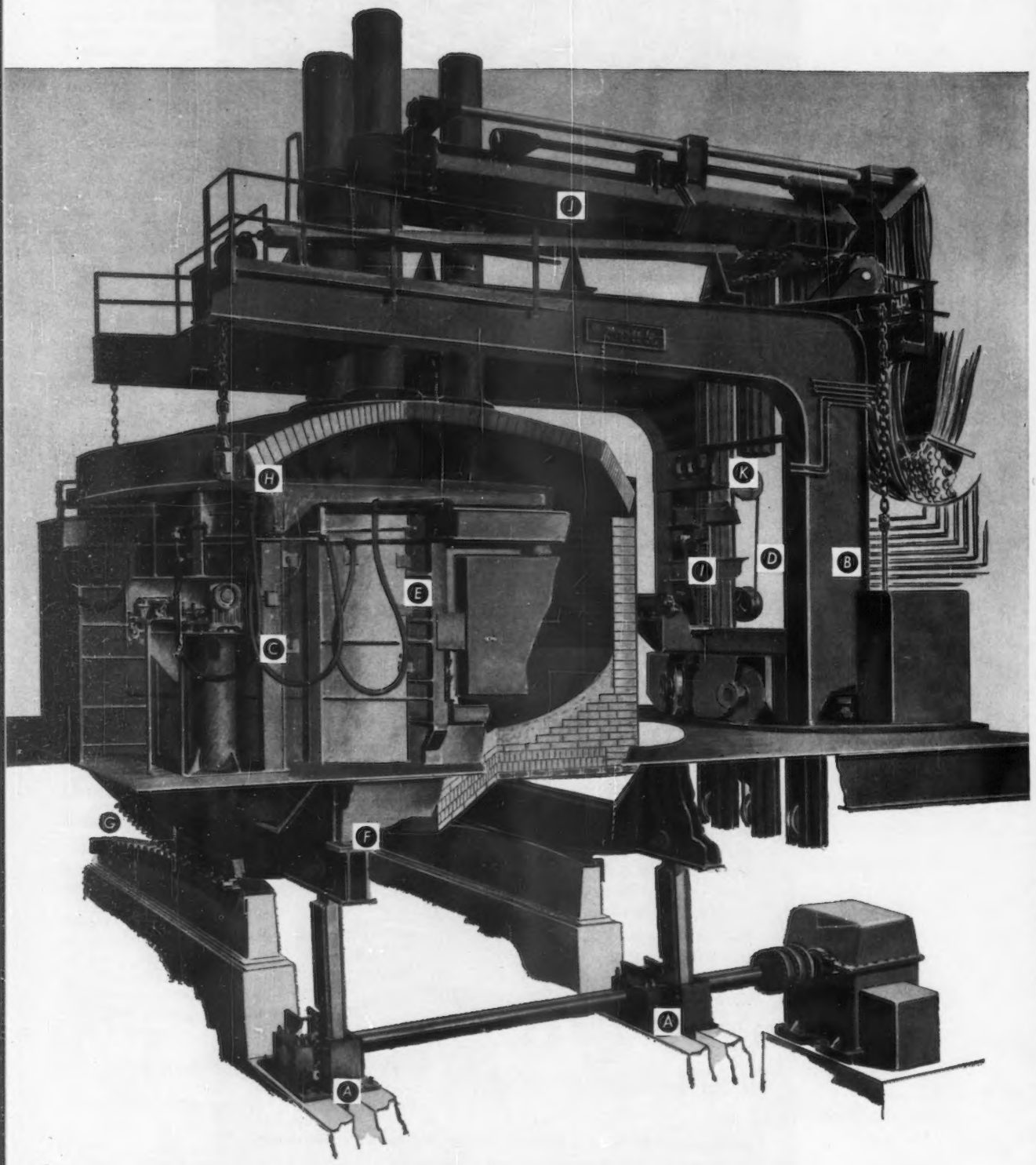

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2. Cage-type shell construction with shell plates loosely attached **(E)** to heavy supporting structure. This construction minimizes shell warping and allows easy replacement of damaged shell plates.

3. Operating mechanism independently supported. The tilting platform on which all operating mechanisms are supported is attached directly to the rockers independent of the shell structure **(F)**. Thus, operating mechanisms are unaffected by shell distortion.

4. Water-cooled, Skew Back Roof ring. This feature **(H)** eliminates the need for special skew-shaped roof refractories.

5. Electrode Mast Safety Device. This spring-loaded, rack-and-pawl-type device **(I)** provides positive protection against damage resulting from electrode winch cable breakage.

6. Square-section, Water-Cooled Electrode Mast Arms. This design **(J)** guarantees a rigid connection between mast and mast arm, thus helping to maintain proper electrode position.

7. Remote-Controlled Electrode Clamps. This device, of the spring-clamp, air-release type, is located inside of the rear section of the water-cooled mast arm where heat cannot affect it.

8. Square-Sectioned Electrode Mast. This design feature **(K)** developed by American Bridge, assures proper guiding and electrode positioning.

9. Rockers. The heavy fabricated steel curved top and bottom rockers **(G)** minimize forward travel during tilting. These rockers are designed so that the furnace will tend to return to horizontal position from any degree of tilt.

American Bridge constructs Heroult Furnaces for all types of arc melting, in charge capacities from 6,000 lbs. to 400,000 lbs. with shell sizes ranging from seven feet up. They are equipped with roof-removing mechanism for fast top charging. They can be furnished with a non-magnetic shell bottom section to accommodate induction-stirring equipment. Gantry-type top-charge furnaces, door-charge furnaces and special furnaces for duplexing and non-ferrous melting are also available. Your crew can easily maintain a Heroult Furnace. Check American Bridge's complete design, construction and installation service.

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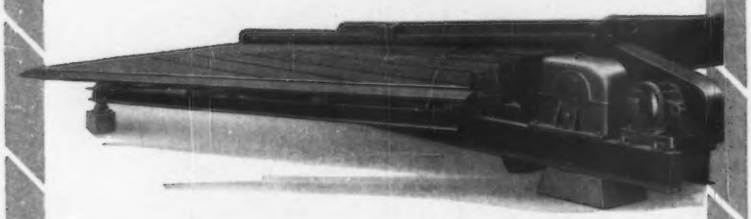

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Flotation *(Continued)*

one might train geologists to find ores that have individual crystallization of mineral particles, not interlocked at sub-micron sizes as in Burma and at the Kimberley property of Consolidated Mining & Smelting in B.C., and when this is done, flotation will do whatever you want it to do."

Van H. Smith, Mineral Dressing Consultant

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Frank R. Milliken, president Kennecott Copper Corp. 50th Anniversary Celebration, Denver, Colo.

The Patent Situation Reported by E&MJ 50 Years Ago

Historic Test at Baker City. "Quite a number of capitalists from Portland and Walla Walla are here, watching the result of some test working of the "Criley & Everson Oil Process" for the extraction of sulphurets from any ore, as the name signifies, by the use of oil. Your correspondent witnessed a test made on the Eureka & Excelsior ore, which was conducted as follows: The ore was crushed and passed through a 50-mesh sieve, weighed and thoroughly mixed with black, thick oil. To water heated to near boiling was added enough sulphuric acid to give it a tartish taste. This acidulated water was then mixed with the mass of oil and ore. A thick scum of sulphurets rose to the surface and was skimmed off leaving the hitherto black ore as white as snow, in fact, pure silica. The gentlemen express themselves as pleased, and the citizens of Baker County are in hopes they are because it means the erection of a large plant at this point."

E&MJ *Nov. 15, 1891*

Everybody's Suing Everybody. "The litigation over the flotation process is a good Kilkenny-fight. Everyone who has got a shillalah is hitting every head in sight. The Elmore people are suing Minerals Sep-

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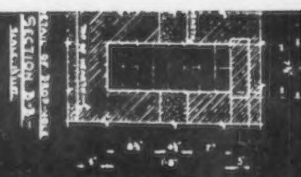

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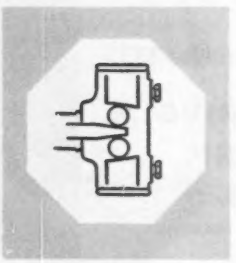

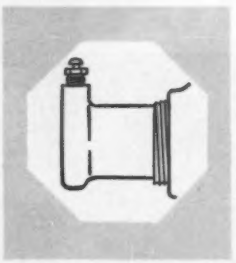

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aration and the latter are suing back. Cattermole, De Bavay and Potter are suing or being sued. In fact, almost everybody is suing almost everybody else, while concerns that own no patents are drawn into the vortex."

E&MJ *Editorial April 15, 1911.*

Don't Fear, Says Editorial. "Most of these so-called flotation processes, as patented by Elmore, Potter, Scammell, Delprat, Sulman, Picard, Ballot, Wolf, De Bavay, Cattermole, etc., are founded on the process invented by an American woman, Carrie J. Everson, and secured by her in U.S. Pat. 348,157, Aug. 24, 1886. . . . American millmen need have little fear from the consequences of using a process described in two patents—one 25 years old and the other which was taken out in Italy and Great Britain."

E&MJ *Editorial April 15, 1911.*

Misleading Advice Says a Reader. "In the editorial entitled 'The Flotation Process', in the Journal of April 15, is stated that the Zinc Corp. in installing the 'so-called Minerals Separation process', Broken Hill has reverted to a process which in all its essentials was described by Miss Everson in her patent which has since expired. . . . It is a fair inference from this and the rest of the editorial that American operators would be safe from actual infringement of valid patents if they installed such a flotation process as the Zinc Corp. has installed . . . the article as a whole is misleading as it fails to give a proper idea of the relative importance of the processes referred to, and is erroneous as to facts . . . Minerals Separation has a string of about 15 patents in the U.S., Canada and Mexico for processes, apparatus and the improvement of apparatus . . . and is determined therefore to carry any infringement proceedings it may have to initiate through to the court of last resort."

Letter to the Editor by E. H. Nutter, May 5, 1911.

Herbert Hoover on Patents. "At the annual meeting of the Zinc Corp. in London, last month F. A. Govett and H. C. Hoover, the joint managing directors made statements respecting the experience of this company with the Elmore and Minerals Separation flotation process. The Zinc Corp. has abandoned the Elmore process in favor of the Minerals Separation Process.

"Mr. Hoover said, 'Now as to the change in processes, I do not know whether you fully understand that all these processes are what are called flotation processes, and the underly-

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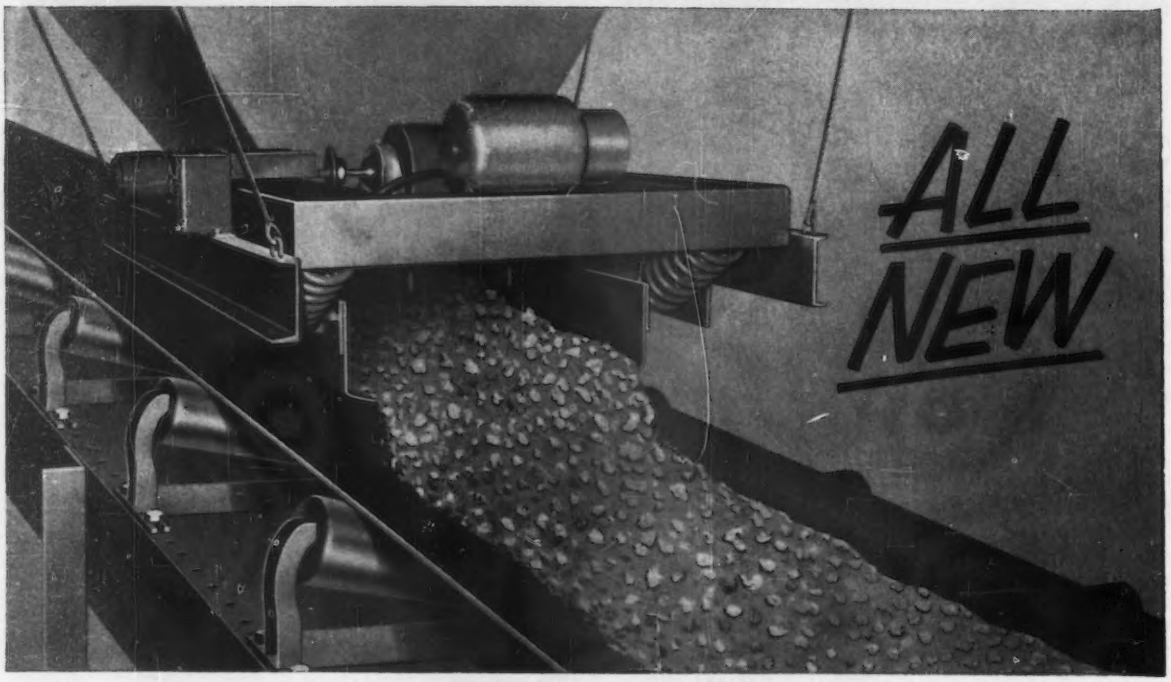

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ing principle of them is very much the same. The principle was known and was used before those who are the present owners were in business at all. On the other hand, they have wrapped them up a mass of patents, litigation and other things, which make it very costly to get through them in Australia.'"

E&MJ *June 11, 1911.*

Patents, Patents, Patents! "There are now upwards of 500 patents registered in various countries bearing on different factors in the processes, but it must be recognized that the original suggestion of flotation by treatment with acid and oil was the work of Carrie Everson. . . . To whom the patents may belong at the present day as a matter of law is a subject which only the courts will be able to determine, and to say the least, this patent litigation is absorbing enormous sums of money and proving a great blessing to the legal profession."

D. P. Mitchell, General Manager, Zinc Corp., E&MJ *Nov. 18, 1911.*

Acknowledgements

E&MJ is particularly indebted to the following men for their contributions to the Salute to Flotation:

Wm. L. Zeigler; A. W. Fahrenwald; C. G. Stunz, of Inspiration Consolidated Copper Co.; Van H. Smith, F. W. Bloecher, Jr. and E. P. Cadwell, of Cyanamid International; Wm. Reck and Wm. Haddon, of Wemco; Clarence Zeuch, of Dow Chemical Co.; L. Roe, of International Minerals and Chemical Corp.; Paul Cook and A. C. Daman, of Denver Equipment Co.; F. W. McQuiston, Jr., of Newmont Mining Corp.; R. W. Hernlund of Pima Mining Co.; E. J. Duggan, of Climax Uranium Co.; and the Colorado School of Mines for permission to reprint illustrations from its quarterly publication on flotation.

Selected References

"50th Anniversary Volume-Commemorating the 50th Anniversary of Froth Flotation in the United States," sponsored by the Minerals Beneficiation Div. of the AIME. Contains 23 chapters on all important phases of flotation written by recognized authorities. Edited by D. W. Fuerstenau. Published by AIME. Price: $10 to members; $14 to non-members.

"Fiftieth Anniversary of Froth Flotation in the U.S.A.," Papers presented at commemoration held in Denver, Colo., Sept. 1961. Two volumes, published in paper-covered form by the Colorado School of Mines, Golden, Colorado. Price $5. Pp 600

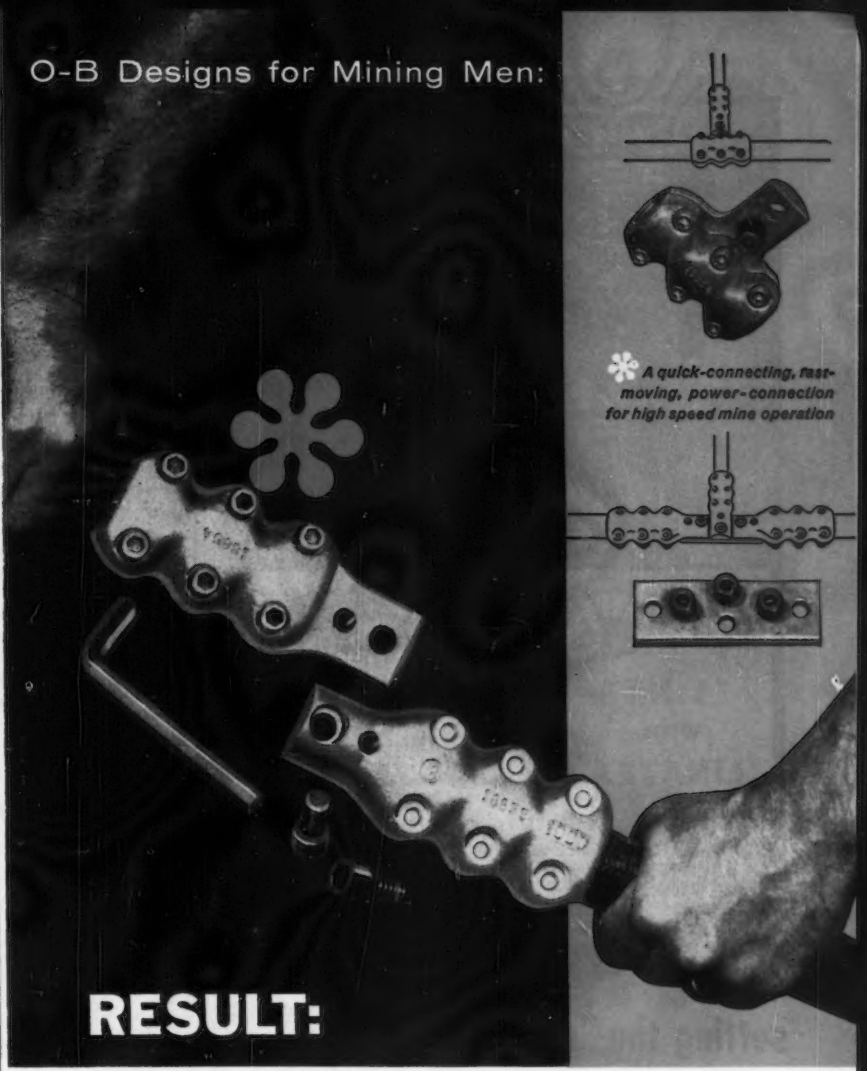
"Flotation," by Gaudin. Second Edition, published by McGraw-Hill Publishing Co. New York City. 1957.

"Richards Memorial Volume on Milling and Concentration," Transactions of the AIME, 1946.

"Development of the Treatment by Flotation of the Ore of the Sullivan Mine, Kimberley, B.C., 1917-1923," by R. W. Diamond. Published in the Colorado School of Mines Volume listed above.

"Flotation's Early Years," by E. J. Pryor. Published in the Colorado School of Mines publication listed above.

"Results in Modern Flotation," Bulletin 2901. Published by the Denver Equipment Co., 1929. At that



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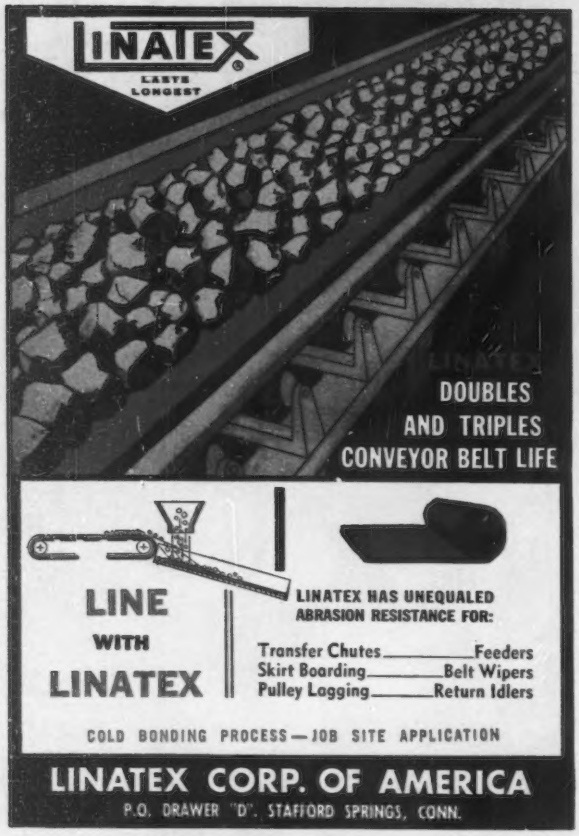

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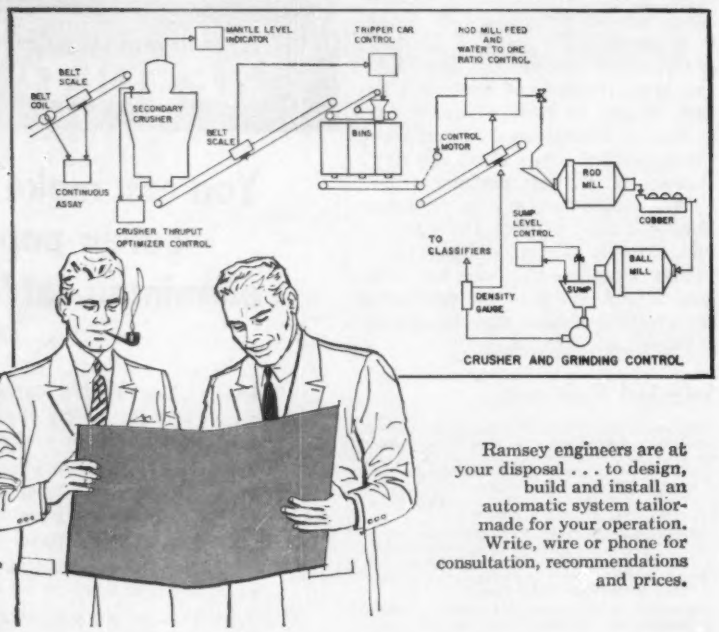

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date, one of the most complete practical discussions on flotation available. Contribution authors include: Charles E. Locke, A. M. Gaudin, C. S. Parsons, Arthur J. Weinig, Irving A. Palmer, A. W. Fahrenwald, A. C. Daman, F. E. Briber.

"Flotation—The Mainspring of the Minerals Industry." Commemoration address by Frank R. Milliken, President, Kennecott Copper Corp., Fifieth Anniversary Celebration, Denver, Colo., September 1961.

Note: The first four references listed above contain bibliographies covering virtually every significant development in the flotation process from its evolution in the 19th Century to date.

Wilderness (*Continued*)

the Senate, U. S. Sen. Frank Church, (D.-Idaho) said in a talk November 7 at Moscow, Idaho.

Sen. Church, who is credited with a major role in steering the bill through passage in the Senate, conceded that restrictions on mining activity are provided in the legislation.

However, he said the bill offers greater protection in some ways than the present law which permits the U.S. Forest Service to set aside wilderness areas by administrative decision alone. The new bill, according to Church, provides for review and veto by Congress of wilderness proposals, a power which Congress does not now have.

The bill passed the Senate by a 78-8 vote in the last session and is now awaiting action in the House.

According to Church, prospecting that would not "violate" the wilderness areas would be permitted without special permission. Commercial prospecting and mining operations would be permitted with permission and the existing mining claims and rights would be respected.

Church has been under fire in Idaho in recent weeks by officials of the mining industry for his stand on the Wilderness Bill.

He said the bill would not create a single acre of wilderness. The wilderness, he added, is "already there", since the bill affects only land already owned by the federal government and now classified as primitive areas.

Homestake-Sapin and AEC Sign Uranium Contract

THE ATOMIC ENERGY COMMISSION has completed mill contracting for the 1962-1966 procurement period in the Grants, N.M. district with signature of agreements with Homestake-Sapin Partners. The purchases cover two mills operated by the Homestake-Sapin and Homestake-New Mexico Partners.

Signature of the contract cleared the way for Homestake-Sapin to acquire the assets of Homestake-New Mexico Partners. A principal in the selling group was Hidden Splendor Mining Co., affiliate of Atlas Corp.

The new agreement, effective Sept. 1, 1961, through the 1966 period, provides for purchase of about 16,862,000 pounds of U_3O_8 valued at $135-million.

The new contract replaces both the Homestake New Mexico Partners agreement which would have terminated March 31, 1962, and the Homestake-Sapin contract which already had been

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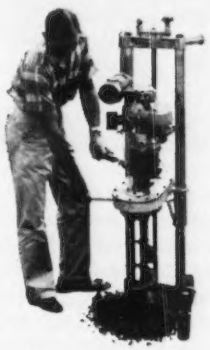

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MOBILE DRILLING, INC.
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NEW··· LOG WASHER DEVELOPMENT

McLANAHAN

Mudmaster

now with Higher-Output 12" Logs

Proved a profit-maker by many dozens of progressive operators, the Mudmaster Log Washer is a powerful, rigid, efficient and economical machine—outstanding for low-maintenance performance . . . effective for cleaning gravel, limestone, phosphate, manganese, iron and other ores. Now with 12" Log models to supplement 10" Logs previously available, the Mudmaster is made in 20', 25' and 30' lengths. *Write for New Bulletin and Price Data.*

McLANAHAN Corporation

HOLLIDAYSBURG, PENNSYLVANIA

Pit, Mine and Quarry Equipment Headquarters Since 1835

extended into the 1962-1966 term.

AEC stressed the new agreements are in accordance with the Commission's announcement of Nov. 24, 1958 providing for the purchase of appropriate quantities of U_3O_8 in the 1962-1966 period from ore reserves developed prior to Nov. 24, 1958 date.

Quantities involved in the new contract include:

From the Homestake-Sapin contract—about 1,342,000 lbs. in pre-1962 term and 10,680,000 lbs. of U_3O_8 in post 1962 term. This is a total of 12,022,000 lbs. U_3O_8 at price of $8.00 per lb.

From Homestake-New Mexico Contracts—1,040,000 lbs. of U_3O_8 per lb. in pre-1962 period. Additionally. 3.800.000 lbs. of U_3O_8 will be purchased in 1962-1966 period, based on allocations for properties acquired from Hidden Splendor and United Western Minerals Co. This brings the total to 4.840 000 lb. at a fixed price of $8.00, AEC said.

Vitro Displays First Be Metal from its U.S. Ore

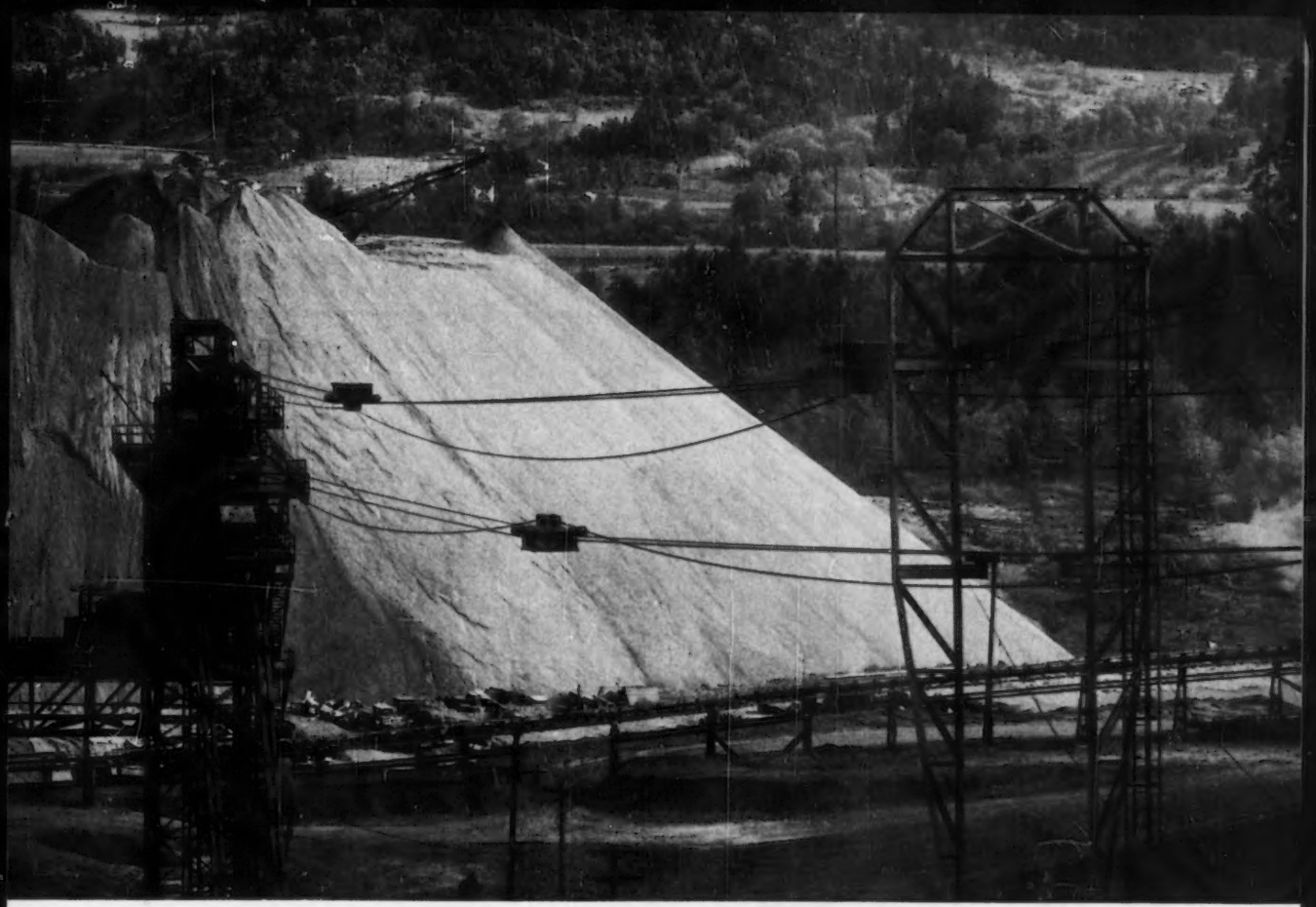
LAST MONTH, Vitro Metals Corp. displayed the first beryllium metal from its U.S. ore—arc welded beryllium metal in "button form".

Vitro had refined beryllium oxide earlier in the year on a laboratory basis. The USBM's Albany Metallurgy Research Center (Albany, Ore.) reduced the oxide to metal sponge and then produced the arc-melted buttons.

Boliden Has A Good Year

In 1960, Boliden Mining Co., produced a record tonnage of ore, while metal production was on the same high level as in 1959, although there were some changes in the proportions of the different products. Sales were on the whole equivalent to production, and amounted to the record sum of 289.3-million kroner (1 kroner = 19.33¢). Gross operating profit and net profit increased to 51.8 and 14.1-million kroner respectively. Dividend was increased from 9 to 10%.

Prospecting was intensified in 1960, both in Sweden and other countries. Boliden has a large and extremely well-equipped prospecting department. At year's end the ore reserves, amounted to about 64-million tons, distributed among 11 mines owned by the company and 2 leased. The ores consist mainly of com-



Aerial tramway moves a million tons of ore every year

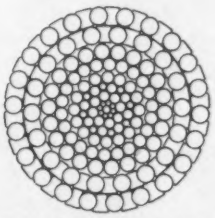
2½-ton capacity ore cars ride smoothly on Bethlehem track strand

In a rugged section of Oregon's Coast Range, The Hanna Mining Company works the only nickel mine now operating in the United States. On top of Nickel Mountain the ore body lies right on the surface; the open-cut mining method is used.

It's 8,300 ft from the loading terminal at the upper level to the smelter stockpile at the foot of the mountain and there's a drop of some 2,000 ft in elevation. A continuous aerial tramway was selected as the most economical way to move the crushed ore downhill over this difficult terrain. The tramway is equipped with 63 ore cars which carry 2½ tons each. Rated capacity is 250 tons per hour, feeding over a million tons a year to the smelter.

50,000 ft of large track strand and wire rope used

Unlike a monocable aerial tramway, the ore cars ride on *two* pairs of Bethlehem track ropes. The upper pair is 2-in. diameter strand, while the lower is 1½-in. diameter locked-coil track strand. This type of track strand has a smooth surface for the carriage wheels, holding vibration to a minimum as the tram car runs over it. It is designed to resist bending and crushing stresses, too, and takes abrasion remarkably well. Altogether, 16,920 ft of each size strand is involved, as well as 16,640 ft of 2-in. diameter Bethlehem Purple Strand wire rope for haulage lines.



Half-locked coil strand is designed to be flexible, yet strong. The 2-in.-diam strand has a minimum breaking strength of 218 tons.

If you would like to know more about wire rope for aerial tramways, simply get in touch with the nearest Bethlehem sales office. They'll be glad to give you full details.

Steel *for Strength . . . Economy . . . Versatility*

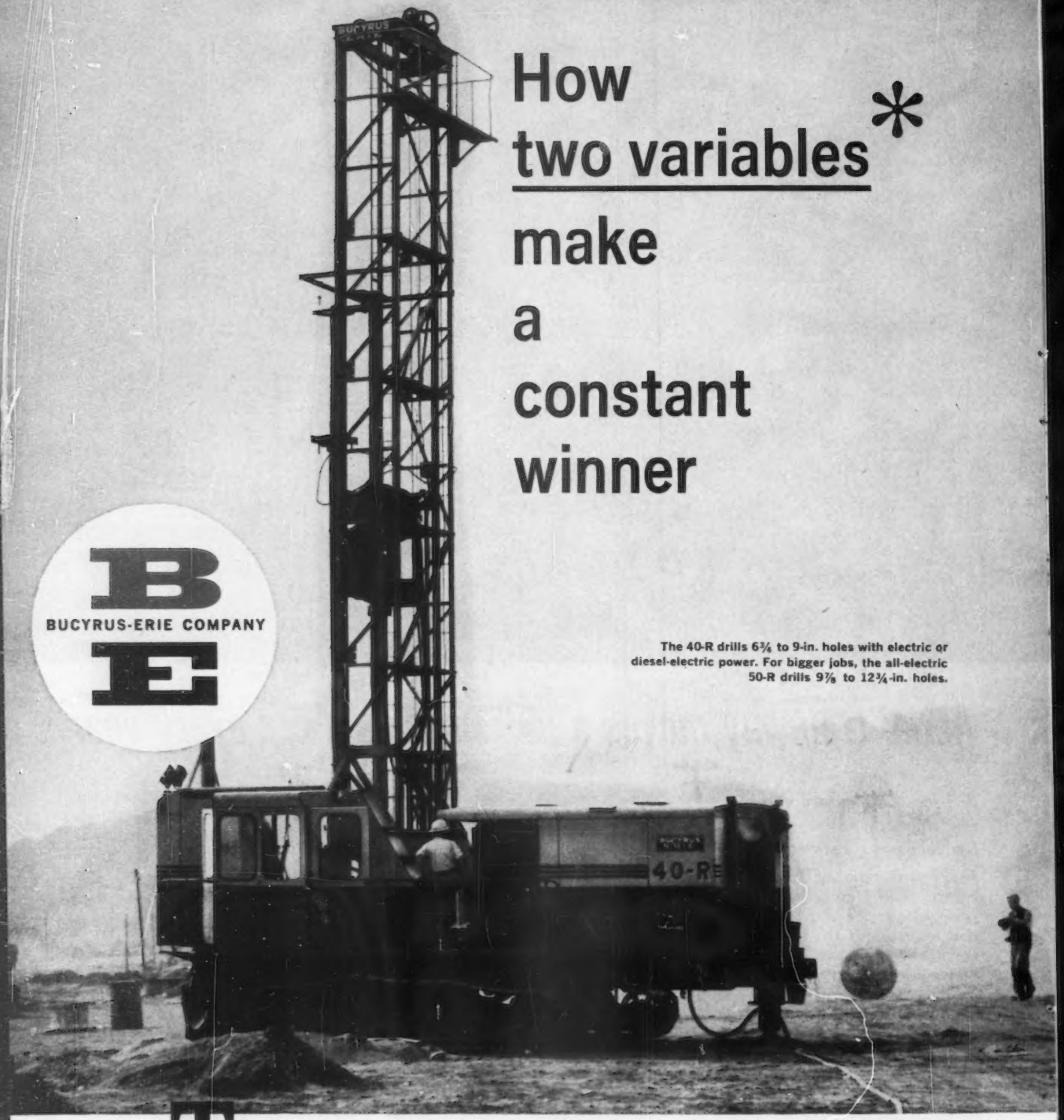
There's a distributor of Bethlehem Rope near you, supplied by our nationwide network of wire rope mill depots.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export Sales: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

How two variables* make a constant winner

BUCYRUS-ERIE COMPANY



The 40-R drills 6¾ to 9-in. holes with electric or diesel-electric power. For bigger jobs, the all-electric 50-R drills 9⅞ to 12¼-in. holes.

The Bucyrus-Erie 40-R has been constantly setting new footage records. Here are two important reasons:

***VARIABLE DRILLING SPEED** — Ward Leonard variable voltage control lets you choose the correct rotary speed for a given formation and adapts instantly to changes without stopping the drilling operation.

***VARIABLE PULLDOWN PRESSURE** — Hydraulic down pressure works in any desired combination with rotary speed. Result: Record-breaking, bit-saving production under all conditions.

Let your Bucyrus-Erie sales representative tell you more about the tough, fast-working 40-R, or write Bucyrus-Erie Company, Drill Division, South Milwaukee, Wisconsin.

2861

plex sulphides containing copper, zinc, lead and sulphur and high lead-sulphide ores. Some ores also contain noble metals.

AN-FO is being introduced at all the mines.

There are four central plants for dressing complex ores, and two local plants for lead ores. The central plant at Boliden consists of two sections, in one of which ores with up to four metal minerals, including iron pyrites, can be treated, and, in the other, ores with up to three metal minerals. This plant also contains a test concentrator in full scale. Secondary autogenous grinding has been introduced or decided upon at five of the ore-dressing plants. The sixth, that at Vassbo, which started operation at the beginning of 1960, works with primary autogenous grinding. Apart from certain initial difficulties, operation has proceeded according to plan.

The most important products of the Boliden Co. are copper, lead, gold and silver, zinc, lead and iron pyrites concentrates, selenium, arsenic, arsenic salts, lead oxides and sulphuric acid.

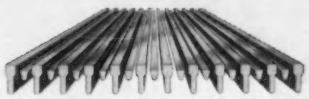
The Boliden smelting works, the essential parts of which consist of a copper works and a lead works, and other plants for the manufacture of metallurgical and chemical byproducts, are at Rönnskär near Skellefteå, on the Gulf of Bothnia. The new investments decided upon in 1960 include a new arsenic refinery, and extensions to the selenium works and the sulphuric acid plant. Among investments in the mining section are the enlargement of the ore-dressing plant at Laisvall, which treats the ore from the largest lead deposit in Europe, and of the ore-dressing plant at Garpenberg in central Sweden.

Boland Sinks 519-Ft Shaft During October

BOLAND DEVELOPMENT CO. LTD. announced that a North American shaft sinking record had been established dur-

WEDGE-WIRE
REG. U. S. PAT. OFF.
Kleenslot
PREPARATION SCREENS
designed for vibrators or stationary applications
—for dewatering, screening, washing, extracting, filtering or sizing

T-WEDGE KLEENSLOT



A new concept in guard bar design. T-shaped wire replaces typical "bar" to increase screening surface while keeping large unscreenable lumps of material above the tolerance governing lower screening surface.

F217 and F250 KLEENSLOT

Large size wires maintain maximum efficiency over an extended period in abrasive applications.
Although large in wire size, this screen will maintain openings as close as 1 m.m.

"S" KLEENSLOT

For applications where screening out of flats or slivers is of prime consideration. Also furnished in a "C" bend. Recommended for applications requiring openings larger than 1 m.m.

MARCEL

This screen, while screening out "slivers," presents a flat surface for materials to wipe the opening clean Available with openings up to 1 m.m.—for larger opening see "S" screens.

SCREEN GUARD

Vertical guard bars keep larger unscreenable materials above the actual screening surface. This increases screen life and promotes much greater efficiency in dewatering.

G187 and GB187 MIGH-TEE KLEENSLOT

Special profile increases wearing surface. This is a heavy duty precision type screen that will easily maintain openings smaller than 1/8 m.m. and openings larger than ordinarily considered economical.

DIG UP NEW SERVICE LIFE RECORDS
retip with Amsco's "Pair for Wear"

Dipper teeth dig in and stay sharp when hardfaced and repaired with Amsco's newest electrodes. Both the Nicro Mang* and X-53—the "Pair for Wear"—will handle up to 90% of your hardfacing jobs where high impact and abrasion resistance are needed.

Nicro Mang replaces stainless steel and lets you weld manganese as easily as mild steel. It is a 14% manganese electrode with a deposit hardness of 175 BHN that work hardens to 500 BHN.

Its companion, the X-53, for all general hardfacing jobs, is as easy to run as Nicro Mang. It has a high deposit rate with no spatter and excellent bead characteristics.

Try this famous "Pair for Wear" on your dipper teeth. Leading welding distributors stock them in 50 lb. manual packages or 50 lb. semi-automatic coils. Or, write for your free sample kit containing both these hardfacing rods.

* TRADEMARK REGISTERED 661

AMERICAN Brake Shoe COMPANY

AMSCO
AMERICAN MANGANESE STEEL DIVISION
CHICAGO HEIGHTS, ILLINOIS

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Denver • Los Angeles • New Castle, Del. • Oakland, Calif. • St. Louis
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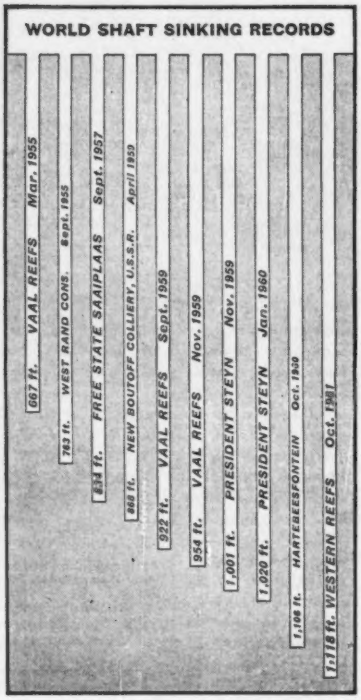
Buy through your local welding supply distributor

ing October. A 20-ft-dia shaft, being sunk for Copper Range Co., was sunk 519 ft and lined with concrete to a depth of 510 ft.

Boland reported that the sinking hoist is a double drum — 72-in.-dia x 42-in. face—powered by a 750-hp electric motor and having a line speed of 1500 fpm. The company also said that collapsible steel forms permitted the placement of concrete in 15-ft sections.


WORLD SHAFT SINKING RECORDS
667 ft. VAAL REEFS Mar. 1955
763 ft. WEST RAND CONS. Sept. 1955
834 ft. FREE STATE SAAIPLAAS Sept. 1957
868 ft. NEW BOUTOFF COLLIERY, U.S.S.R. April 1959
922 ft. VAAL REEFS Sept. 1959
954 ft. VAAL REEFS Nov. 1959
1,001 ft. PRESIDENT STEYN Nov. 1959
1,020 ft. PRESIDENT STEYN Jan. 1960
1,106 ft. HARTEBEESFONTEIN Oct. 1958
1,118 ft. WESTERN REEFS Oct. 1961

South Africa Again Sets New Shaft-Sinking Record

NEW SHAFT SINKING RECORD was established during October at South Africa's Western Reefs (Klerksdorp) No. 4 Shaft —1181 ft.

The previous record, 1106 ft, was established at the neighbouring Hartebeesfontein mine a year ago.

The record was broken with a smaller capacity hoisting gear, a smaller capacity mechanical grab working through harder rock than the previous record-breaking shaft. Team work enabled the four shifts of sinkers, engineers and mineworkers to maintain an average cycle—drilling, blasting, clearing—of four hours 34 minutes during the month.

In the three months since the shaft sinkers took over on July 25, the shaft has been sunk 2785 ft. Its estimated diameter is 28½ ft concrete lined to a finished size of 26 ft.

IN THE U.S.

ALASKA

The Red Devil Mine, on the Kuskokwim

Here are five important questions . . . and their answers . . . on an important new Simplex development in electric power distribution and transmission

HIGH VOLTAGE POLYETHYLENE

INSULATED POWER CABLES

Q. *What are some of the advantages of Simplex polyethylene-insulated high voltage cables?*

A. Low dielectric constant (nearly 1/2 that of paper cables) . . . Low power factor (nearly 1/10 that of paper cables) . . . Low dielectric loss (nearly 1/20 that of paper cables) . . . Very high insulation resistance (at least 10 times that of paper cables) . . . High dielectric strength . . . (equal to paper cables).

Q. *What are some of the outstanding physical properties of Simplex polyethylene?*

A. Light weight (62% of paper cables) . . . High tensile strength (1800-2000 p.s.i.) . . . High elongation (400% minimum).

Q. *Where can Simplex polyethylene cables be used?*

A. In many places where rubber or paper cable is used. Typical installations are direct burial, duct or conduit, aerial and submarine.

Q. *What is the highest voltage at which Simplex polyethylene cables are rated?*

A. Simplex now has polyethylene cable rated as high as 46KV A-C. Development work now in progress is expected to extend Simplex polyethylene's voltage range to 69KV or higher.

Q. *Has Simplex high voltage polyethylene cable been thoroughly field tested?*

A. Yes, as the leading producer of polyethylene cables, Simplex has in service more than 330 mile-years of polyethylene-insulated cable in the 5KV to 46KV range.

Send for complete information.

Simplex
WIRE & CABLE CO.

EXECUTIVE OFFICES: Cambridge, Mass.
Plants at Cambridge, Mass., Portsmouth, N. H., Westbury, L. I., Monrovia, Calif.

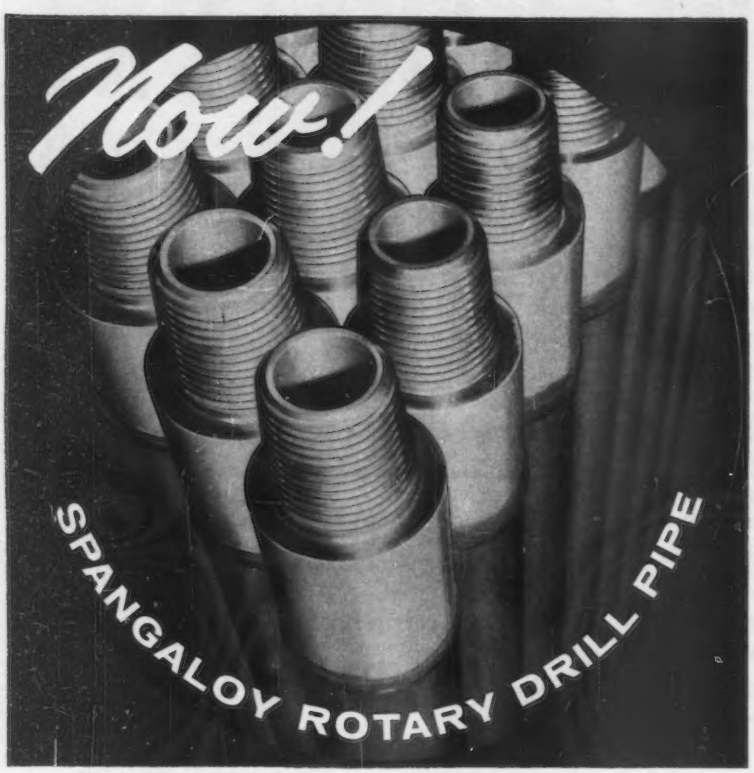
River near Sleetmute, and one of the three largest mercury mines in the U.S., is now shipping a portion of its product to Japan. The Japanese purchasers are taking the mercury in its partly refined form of soot. Shipments are by way of Northern Consolidated Airlines to Anchorage and by the Kazukawa Steamship Line from Anchorage to Japan. Production at the Red Devil is reported up 15% over last year at this time, and a year's output of 5000 flasks will probably be realized.

James D. Crawford, vice president and general manager of the Alaskan operations of the USSR&M Co. has announced that rising costs are causing a shutdown of all dredges in the Fairbanks area by the end of 1963, and a shutdown at Nome possibly as early as 1962.

ARIZONA

Kennecott Copper Corp. won a $273,685 refund of 1959 property taxes paid in Pinal County following reduction of assessments in mining claims from $25.5-million to $19.15-million.

The firm had appealed Arizona Tax Commission's assessment to the Pinal County Superior Court and a jury fixed valuation at $18.65-million. This verdict appealed to the Arizona Supreme Court by the state resulted in the compromise figure of $19.15-million.



THE DIFFERENCE SHOWS UP IN PERFORMANCE!

SPANGALOY Rotary Drill Pipe is produced in sizes up to 8⅝" O.D.

Welding techniques developed after exhaustive tests
together with the right combination of steels
insure superior wearing qualities and toughness.

For less downtime . . . more profit . . . specify better performing SPANGALOY Rotary Drill Pipe on your next order. SPANGALOY replacement joints also available.

SPANGALOY TOOLS

SPANG & COMPANY · BUTLER, PA. / BRANCHES: Bolivar, N.Y., Mt. Pleasant, Mich., Winfield, Kan.

COLORADO

The Colorado Industrial Commission set a precedent in the state by awarding $11,466—the maximum—in death benefits to the widow of a uranium miner who died of lung cancer.

It was Colorado's first case in which the effects of radiation as a working hazard were judged.

Testimony showed that Robert D. Johnson, 43, operator of the Johnson Mining Co., died of lung cancer caused by exposure to radioactive materials. Johnson, who was 43 when he died in November 1958, had operated the mine with his wife since 1949.

He was one of 3300 underground miners in a control group being studied by the U.S. Public Health Service. The 4-state study was to determine radiation effects on miners.

An autopsy after Johnson's death showed "excessive amounts" of radio-lead in his bones, kidneys, liver and muscles. Radio-lead is the final product of radioactive materials called radon daughters which come from radon gas produced in uranium mines.

Dr. Richard Archer, U. S. Public Health Service representative, testified there is a direct causal relationship between lung cancer and prolonged exposure to large quantities of radon.

Hack Engineering Co., designers, fabricators and installers of equipment for the raw material processing and material handling industries, was recently purchased by J. B. Ehrsam & Sons Mfg. Co., Kansas.

Production of all Hack products will be continued by a newly-formed Ehrsam division, and the Hack engineering staff will be maintained in the merged operation.

IDAHO

Idaho Copper Mines, Inc., Salmon, has obtained a contract from the Office of Minerals Exploration at Spokane for an $80,030 cobalt exploration project in Lehmi County. The OME will pay half of the costs, and work—including downhole drilling and possibly some tunneling—will be done in the Indian Creek mining district.

Idaho Mining and Milling Co., Lewiston, said its dredging operation in the Florence basin area recovered 372 oz of gold-amalgam during the first two weeks of October. Officials said a coarser gold is now being recovered.

Stockholders of Federal Resources Corp. of Utah have been told by company officials that current development work could reach the silver vein in the company's Conjecture mine on Pend Oreille Lake in North Idaho by mid-winter. A three-compartment shaft has been deepened to the 2000-ft level and underground development work to reach projected ore zones 1200 ft from the shaft is well under way, R. W. Neyman, mine manager, reported.

Reorganization of the Silver Belt Lead

No guesswork, ever, with Republic Mine Roof Bolts. Every shipment carries certification of strength rating, yield point, and identifying heat number.

Steel
Strong
Modern
Dependable

WHEN YOU HAVE TO BE RIGHT... SPECIFY REPUBLIC CERTIFIED MINE ROOF BOLTS

No one wants to guess about mine roof support. That's why Republic sends a "certified performance" document along with every shipment of Republic Mine Roof Bolts.

Just a piece of paper—but it says this to you: "These are *safe* bolts, made in accordance with the latest, most advanced mining technical knowledge. Republic made them, and stands solidly behind them."

Republic's knowledge of roof bolting requirements comes from many sources. One important source—Republic's own mines. Another source—first-hand, personal investigation by Republic Field Engineers. Above, for example, George Allen, Republic roof bolting specialist recently acted as consultant on this special job. Sandstone strata required lateral installation of bolts through flexible strapping, to provide larger bearing surface. Republic Mine Roof Bolts were tightened to 200 ft. lbs., or four tons.

Republic Field Engineers are on call, to help *you* take the guesswork out of roof bolting, too. No cost. Just call your Republic distributor, or address your request to Republic Steel Corporation, Department EJ-2903, 1441 Republic Building, Cleveland 1, Ohio.

REPUBLIC STEEL

REPUBLIC HAS THE FEEL FOR MODERN STEEL

"EUC" C-6

lowest cost tractor in the 200 h.p. class...

SERVICE ACCESSIBILITY

. . . years ahead engineering gives fast, easy access to major components to cut repair and replacement labor time. Compared with a competitive crawler of the same class, the C-6 saves 7 hours on a radiator replacement, 5 hours on a drive sprocket, 6 hours for an engine change, 17 hours on recoil system replacement. Every hour cut from downtime means more productivity and lower operating cost.

PROVEN POWER TRAIN

. . . every component, the GM 6-71 engine, Allison Torqmatic Drive and Euclid planetary final drive, are job proved for long service life and efficient performance. Parts and service are readily available everywhere.

LOWER ENGINE PARTS COSTS

. . . individual engine parts . . . pistons and rings, liners, connecting rods, etc. . . . are lower in cost . . . up to 72% less. And a complete engine replacement from fan to flywheel costs only half as much in the C-6!

If you're interested in cutting costs and getting more crawler production, check the Euclid C-6 . . . the lowest cost tractor and most versatile, by far! Your dealer has facts and figures and can probably show you a "Euc" crawler at work on a nearby job.

GM GENERAL MOTORS EUCLID

EUCLID

DIVISION OF GENERAL MOTORS, HUDSON, OHIO

Plants at Cleveland and Hudson, Ohio and Lanarkshire, Scotland

Mines, Inc., in the Coeur d'Alenes, has been completed by eliminating the word "Lead" from the name and changing it to Silver Belt Mines, Inc. the firm owns 28 claims in the silver belt area near the Sunshine mine in North Idaho and its directors are W. M. Yeaman, Yakima, Wash.; Norman M. Smith, Kellogg, and Harry F. Magnuson, W. C. Rullman and A. A. Amonson, Wallace. Yeaman is president.

An automatic sand-filling system, placed in operation this summer at the Bunker hill mine in Kellogg, is now being used for fill work in the Orr and Rogers areas of the mine and sand-pouring will be started early this winter in the Shea area of the property. Approximately 12,000 tons of sand has been poured in the two stoping areas to date.

Norman M. Smith, manager of the Clayton Silver Mines, reports that ore now being mined from the new bottom level of the property contains more silver than ore mined at higher levels and he also said the orebody has increased in size. Plans are being made to increase the capacity of the firm's mill by about 50%, Smith stated. The silver content of ore being stoped from the mine's 800 ft level is 6 to 8 oz. per ton compared with 4 to 5 in the upper workings, Smith reported. He said also that Clayton should be able to qualify for all the lead-zinc it can produce under the new so-called small mines aid bill, and, if such is the case, it stands to be the only Idaho producer to benefit to any extent from the much-debated legislation. Clayton has not produced more than 2750 tons of combined lead and zinc in any year since 1956.

East Coeur D'Alene Silver Mines Co., Wallace, has purchased properties adjoining the Nancy Lee mine near Superior, Mont. It included more than 2000 acres and 100 claims.

The newly-formed company acquired the properties from Jay Bettles, St. Regis, Mont., and T. R. McKinnon, E. W. McKinnon and Rex Logan, all of Superior.

A Yakima, Wash., mining man, W. M. Yeaman, has been named president of the East Coeur D'Alene firm. He is president of Clayton Silver Mines and Sunshine Consolidated, Inc., both with headquarters at Wallace. Norman M. Smith, Kellogg, Idaho, is vice president, and H. F. Magnuson, Wallace, is secretary-treasurer.

LOUISIANA

The Freeport Sulphur Co. will open bids on a $3.5-million new production platform for its sulphur mine in the Gulf of Mexico off Grand Isle, according to E. D. Wingfield, vice president of the company.

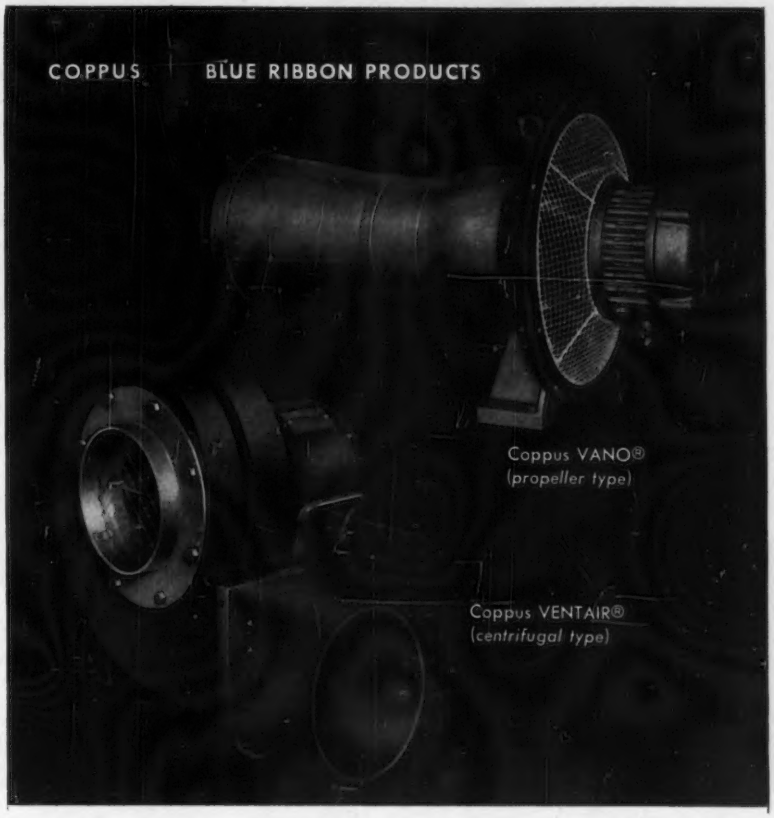
Completion of the new unit is expected next summer. It will expand the world's largest man-made island by 1500 ft, bringing the total length of the entire structure to 4076 ft. The new unit will be the second arm of the "Y" incorporated in the original design. It will start at the heliport and angle to the south. The end of the platform will be about 1500 ft due south of the present production platform.

Freeport will use the new platform to drill wells into the sulphur deposit and to install equipment for bringing the ore to the surface. There will be 36 well openings on the new unit, as there are on the existing platform which has been in operation since April 1960.

MICHIGAN

The Quincy Mining Co., Mason, has moved its tailings dredge from the No. 1 bank to the No. 2. About one mile of 20-in. pipe will be needed to carry the tailings from dredge to reclamation plant, and also a 1000-hp booster pump to push some 3000 tons of tailings per day through the longer line.

The 20-ft-dia concrete shaft being sunk by White Pine Copper Co. at its Southwest property was down to about 2000 ft at the end of October. Exploration drifts will be driven in the orebody to provide samples which will be tested at the company's White Pine mine about two miles away. If these tests prove that the samples concentrate as satisfactorily as drill cores have indicated, a production shaft will be put down 2000 ft



GET 30% TO 100% MORE AIR

Coppus Blowers for mine ventilation include the centrifugal VENTAIR for long pipe lines and the propeller-type VANO for shorter lines. For a given power consumption both deliver from 30% to 100% more air than an ordinary fan.

Serving as blowers or exhausters they are driven either by electric motor or compressed air, with capacities up to 60,000 CFM. Like all Coppus Products, these blowers carry the same "Blue Ribbon" assurance of quality and dependable performance.

Representatives located in all mining areas. Other Coppus "Blue Ribbon" products: Steam turbines, gas burners, heat killers, air filters, blowers and exhausters for special purposes. See also *Thomas' Register*. Coppus Engineering Corporation, Worcester 10, Mass.

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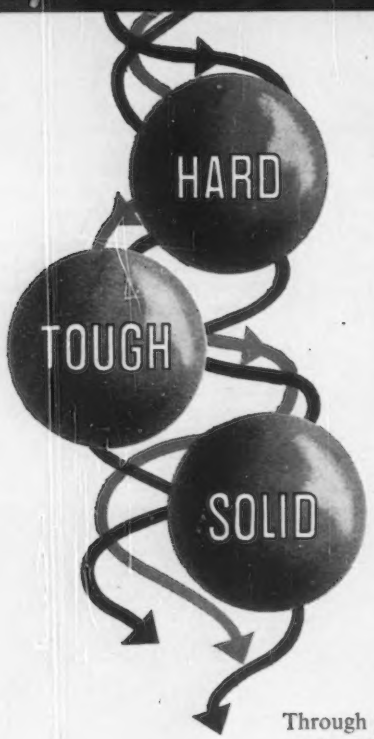
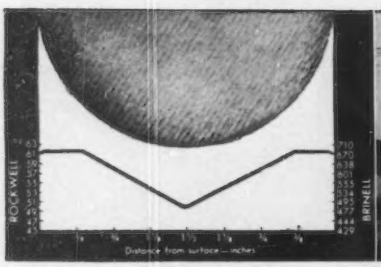
COPPUS BLOWERS



Naco Heat-Treated Cast Alloy Steel Grinding Balls

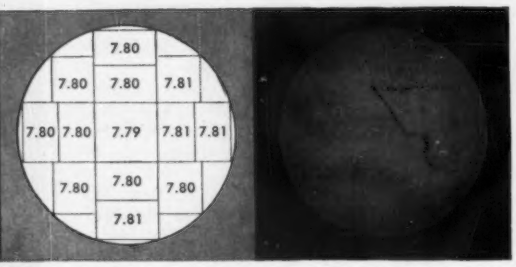
Through precise laboratory controls of the elements in steelmaking — right from spectrographic analysis through final heat treating — Naco Grinding Balls possess the precise structure and hardness for maximum impact absorption and wearing qualities. That's why Naco Grinding Balls are solid favorites with hard-to-please mill operators doing tough grinding jobs.

A-5227A



HARD. Curve shows controlled hardness between surface and inner core. Figures are average hardness of samples taken from representative production runs.

TOUGH. Naco Balls resist breakage longer because of close metallurgical control in electric furnaces . . . quality controlled pouring into special molds . . . careful heat treatment.



UNIFORM SOLIDITY. Grid, at left of X-ray photograph of Naco Ball, shows average specific gravity of various sections. Figures are from 169 three-quarter inch sections from 13 production balls.

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Cleveland 6, Ohio

CAPITOL FOUNDRY DIVISION
POST OFFICE BOX 750
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north of the present shaft, which will ultimately be utilized for servicing and for ventilation. While the production shaft is being sunk, development work will be carried on from the test shaft.

The Michigan Tax Commission has announced that mining company assessed valuations have been reduced in four communities. The Commission said that the reductions would bring mining properties more nearly in line with other plants. Total assessed valuations of the communities and the reductions allowed are: Bessemer; $4,235,000, reduced by $754,000; Wakefield; about $3-million, reduced by $647,600; Bessemer Township, about $5-million, reduced by $1,-484,000, and Erwin Township; $1,-984,825, reduced by $481,000.

The Sunday Lake underground mine at Wakefield, operated by Pickands, Mather & Co., was permanently closed in April of this year. The mine was opened in 1885 and has shipped a total of over 21-million tons. Pumping has been continued since the mine's closing. In early October, it was announced that the property had been bought by four men: E. J. Mascotti, J. A. Bria and W. F. Pellow, of Bessemer, and Rhoderic Tregembo of Ironwood. Pickands Mather officials said the sale was made" on a favorable basis to the purchasers with the hope that the new owners may be able to furnish employment and contribute to the support of the community and schools of Wakefield." Details of the property transfer and just what was included in the sale were not made public. Although an early reopening of the mine is hoped for, nothing definite has yet been announced.

MINNESOTA

M. A. Hanna's Enterprise open pit mine near Virginia has been exhausted and operations were concluded in early October. The mine was opened in 1952 and has produced about 7-million tons. Its best year was in 1955 when it shipped 1,545,634 tons. The mine normally employed about 125 men. Present employes, as well as mine equipment, will be transferred to other Hanna properties on the Mesabi range.

Dr. Randall T. Klenme, Omaha, vice president of the Northern Natural Gas Co., met with Duluth & Iron Range Area Redevelopment officials, city officials and community leaders in Duluth on Oct. 3, and it was decided to sponsor a study to help determine the feasibility of direct reduction iron ore process, for use in northeastern Minnesota.

The study, to be conducted by the Battelle Memorial Institute of Columbus Ohio, will begin soon and is to be completed in two months. Dr. Klenme said that his firm had carried on a study two years ago, but "discovered that the market for direct reduction product was not ample to justify operations in this area," and the program was discontinued. "With the increased interest shown by firms and individuals in this area," he explained, "we have

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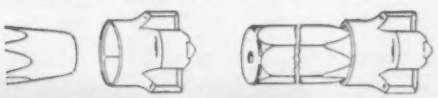

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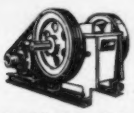
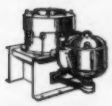


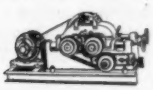
4"x 6" Massco Laboratory Jaw Crusher

Welded steel frame; manganese steel jaw and cheek plates; bronze bushed bearings; smooth jaws give better product and easier cleaning. Adjust for plate wear and product size by convenient hand wheel adjustment.



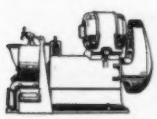
6" and 10" Massco Gy-Roll Reduction Crusher

Reduces ½" feed to as fine as 10 mesh in single pass. High capacity, low power consumption.



Laboratory Crushing Rolls

Sizes (Diameter x width): 10"x 6" and 12"x 8". Adjustable roll space setting up to ¾". V-belt drive. Heavy, cast frame absorbs vibration, results in long life.



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OFFICES AND AGENTS IN PRINCIPAL CITIES

decided to update this study"—"to determine whether the market has changed."

Jones & Laughlin's Lind-Greenway open pit mine, between Coleraine and Grand Rapids, is adding a heavy media and jigging unit to its washing plant. This was included in the original plans when enough low grade ore, which could not be treated in the washing plant, was exposed. The new unit will be ready for the 1962 season. Construction is now underway.

MONTANA

Montana-Coeur d'Alene Mines, Inc., Spokane, reported a promising strike of lead-silver ore at the Bay Chief property near Eddy Creek in Sanders County. Officials said a third exploratory hole, put down to test the downward extension of a vein uncovered by bulldozing, disclosed heavy mineralization in what appears to be a rich silver and lead ore shoot. They said the 31-ft thick vein was cut at a vertical depth of 175 ft.

Anaconda Co. and principals in the Topaz Beryllium Joint Venture of Salt Lake City announce formation of Topaz Beryllium Co.

Officers are Roland B. Mulchay, president; William T. Swensen, vice president and Robert G. Dwyer, secretary and treasurer.

They also serve as directors with E. H. Snyder and Paul Gemmill.

Mr. Mulchay and Mr. Dwyer are officials of Anaconda Co. in Salt Lake City and Mr. Swensen is a beryllium authority working for Anaconda out of New York City.

Mr. Snyder is president and Mr. Gemmill an officer of Combined Metals Reduction Co., Salt Lake City. They headed, with others not in CMRCo., the original venture in the Spors-Topaz Mt. mining district northwest of Delta.

Anaconda Co. recently reported that is building a road on company property north of East Broadway to transport ore from the Mountain Con, Steward and Kelley mines to a central shipping point at the Berkeley Pit. Officials said that a better mix of high grade and low grade ore is expected and this, in turn, will improve the recovery of copper at the Anaconda smelter.

NEVADA

Bristol Silver Mines Co. is producing large tonnages of copper, lead, zinc and silver ore from its property 25 miles northwest of Pioche in Lincoln County. The mine is an underground operation which employs 15 men under direction of Byron S. Hardie, general manager. Ore is shipped by rail to Utah for smelting.

F. & C. Mining Co., Gabbs, has completed its exploratory work for Utah Construction Co. in the iron ore district

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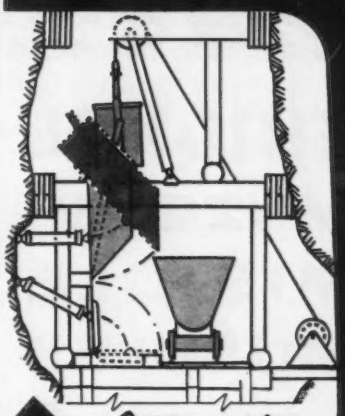

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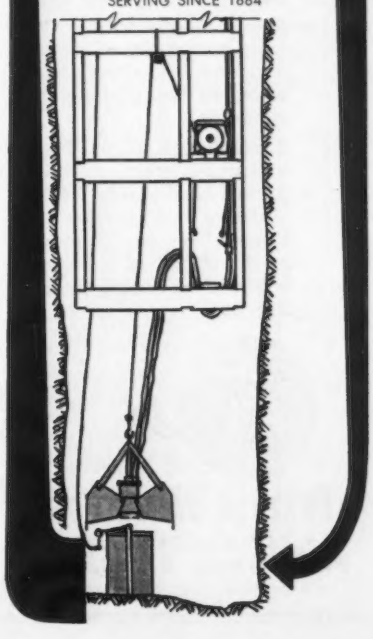

THIOKOL MUZZLES MISSILE MUSCLES

Thiokol Chemical Corporation makes the "muscles" for missiles at the giant Longhorn Ordnance Works, Marshall, Texas. Keeping the latest in solid missile fuels from "blasting off" in production, yet controlling the flow of such hot stuff to motor cases, was the problem.

Thiokol's answer was Farris Flex Valves...providing full pipe capacity for hard to handle solids, along with quick and positive shut-off. Other factors influencing Thiokol's selection were the vibration-absorbing qualities of Farris Flex Valves and the absence of internal parts and obstructions to block the flow of dangerous materials.

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east of Dayton in Lyon County. Marvin Porteous, representative of F. & C., said the property had developed a high potential and that possibilities were great. During the exploratory program, one carload of ore per week was shipped to Provo, Utah, for testing.

White Caps Gold Mining Co. has completed the surface and access rehabilitation work on the Patriot mine near Austin, and plans to start producing gold ore before the end of 1961. Hugh Cameron, superintendent of White Caps, said all bulldozing work had been finished and the access road had been graded to permit the moving in of heavy equipment. A Caterpillar diesel generator, an electric hoist and an electric pump have already been moved to the site. Water is standing up to 200 ft below the collar of the Patriot, but little difficulty is anticipated in getting rid of it since it has presumably run in from the surface. During its early career, the Patriot produced some high grade gold ore as well as $3.5-million worth of silver. White Caps Co. engineers have located more valuable ore in the property.

Combined Metals Reduction Co. is producing perlite from the Hollinger Pit, 18 miles northeast of Pioche in Lincoln County. A. J. Kirkman, of Pioche, has the contract for the strip mining project, and 11 men are employed on the site. The ore is crushed, screened and sized at Combined-Metals Reduction Co. mill at the Caselton mine site, four miles west of Pioche. Otto Jones is superintendent of the mill which employs nine men.

NORTH CAROLINA

Baxter L. Morris, W. C. Lanier and Glen Nance, all of Denton, have leased the old Cotton Patch Gold mine six miles north of Albemarle, from Sam Brewer and are using bulldozers to help unearth new veins of ore.

Geologists have examined some 1400 samples of ore taken from the area and say the mine looks promising. Lanier said he believes he can pan $100 worth of gold daily on a regular basis.

Although never worked on a commercial basis, the property has a history of gold findings since Civil War Days.

UTAH

A Utah highway construction crew recently made a discovery of silver lead zinc ores while widening a road in the Alta district, 18 miles east of Salt Lake City. The bull-dozer operators, however, never realized what they had found—until two Midvale miners working in the area drove by and saw the ore exposed.

They established location markers and proceeded to dig—including digging under the highway. They managed to obtain lease on 200 acres of ground through which the vein apparently strikes.

Rico Argentine Mining Co. forecasts a 65% increase in sulphuric acid production during the current fiscal year, shareholders were told at annual meeting in Salt Lake City.

The plant is one of the few in the U.S. which produces H_2SO_4 from pyrites mined at Rico mining district in southwestern Colorado. The 200 tpd facility has undergone considerable technical changes in the roasting of the pyritic ores in last couple of years.

Sherman B. Hinckley, Rico president, said the many setbacks which confronted the firm in placing the pyrite-sulphuric plant in operation had now been overcome.

The sulphuric goes largely to uranium plants in Colorado, Utah and northern Arizona.

Mr. Hinckley announced that mining and milling of lead-zinc-silver ores in fiscal year ended June 30, 1961 was about "half of normal" but more than paid its way. He said a 10¢ to 20¢ an oz increase in the price of silver would mean a hike of between 50¢ to $1 a ton on value of ore mined. Rico plans to ask the Federal government for a subsidy on some of its mines in the Colorado district, provided Congress gives money for the $16.5-million small mines plan approved by the President.

Three Salt Lake mining men announced the discovery of what they called a major beryllium deposit near Virgin Peak, 14 miles south of Mesquite in Clark County.

The men are Jack O. Horton, manager of Beryllium Associates, Inc., Salt Lake City and partners Sherman B. Jensen and Gaylen W. Hansen. Horton is former general manager of Vitro Minerals Corp.

WASHINGTON

Sunny Peak Mining Co. has leased the upper portion of its mine workings near Conconully to H. V. Davidson, Reardan, and Elmer Cook, Republic. The two lessees have built a road to the old No. 1 Mohawk tunnel. The tunnel has been reopened and the operators plan to ship lead-silver ore to the Cominco smelter at Trail, B.C.

A 400 tpd mill is being considered at the old Schumaker mine north of Colville, according to officials of Triton Mining Co. The property is being developed by Goldfield Consolidated Mines Co., San Francisco, under an agreement with Triton. A lead-zinc-silver orebody is being developed at the 600-ft level. So far, the ore has been showing a good content of zinc. Development work is expected to continue on a two-shift basis during the fall and winter. The mill would be constructed in the spring if justified by ore developments.

In early November, Kaiser Aluminum & Chemical Corp. cut its primary aluminum production rate from 90% of capacity to 86%. The curtailment took place only at the firm's Mead plant,

where 135 workers were affected. Kaiser's inventories have been built up to a level consistent with current sales, and at the 86% rate, operations will be at a substantially higher level than at the first of this year, a company spokesman said. The cut will mean reducing total annual production from about 546,500 tons to about 524,500 tons. Production at capacity is 609,500 tons.

Northwest Prospecting & Development Co., Spokane, said it has leased thorium properties in the Hall Mountain area of northern Idaho to R. J. Hundhausen, L. L. McLean and G. Fansler, all of Spokane, and Clair Wynecoop, Wellpinit. Hundhausen said additional ore has been opened up by bulldozing and the continuation of a thorite vein has been determined over a distance of 450 ft.

Officials of Spokane National Mines said the firm's mill at Bannack, Mont., is being operated around the clock six days a week under a custom milling contract to handle 10,000 tons of ore for the Hand Mining Co., of Argenta, Mont. The firm expects to complete the work by Jan. 15.

The company said high grade development ore is being prepared for shipment at the nearby New Departure silver mine.

WYOMING

Page Morris, president of Duval Sulphur & Potash Co., said his firm is engaged in an "economic evaluation" of phosphate reserves at Sublette Ridge, near Border.

He said that Duvall had an "understanding" with Kern County Land Co., San Francisco, in regard to mineral prospecting in the West.

"I'd say we were jointly prospecting the area. We now want to determine whether there is anything more than a prospect here," Mr. Morris said.

During the last year, some trenching, core hole drilling and underground examination was carried out by Kern County and Duval in reserve estimation.

The study outlined by Mr. Morris would include economics of beneficiation, mining costs, market demand and transportation charges.

CORRECTION

In a recent article concerning United States Milling & Minerals Corp., on page 164 of your October 1961 issue, I was misquoted by giving the impression that the company was prepared to go out of business and abandon its mining and milling operations. This is absolutely not the case.

Recently, for the period from December 1960 through July 1961, United States Milling & Minerals Corp. spent in excess of $350,000 on a development and modernization program for its mines and mill, with considerable truck haul road improvement. This program greatly

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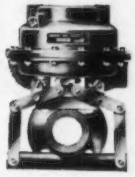
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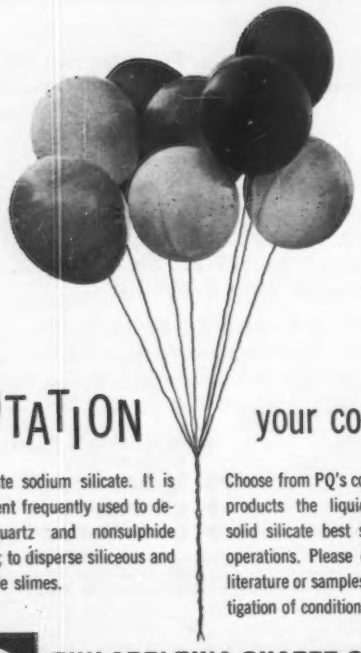

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J-12-61

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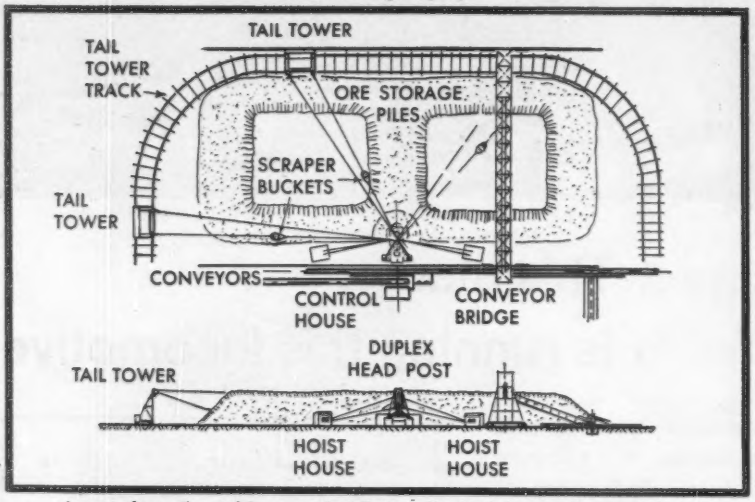
Reclaiming Ore By Remote Control

SAUERMAN DRAGSCRAPERS HAUL 2300 TONS PER HOUR

One of two DragScraper Machines reclaiming from storage piles of an African mining company.



Layout of ore piles and Sauerman installations. The 6-yd. Crescent Scraper Buckets operate between two movable tail towers and a duplex head post.

At this African installation, two 6-yd. DragScraper Machines reclaim ore at 2300 tph. on average hauls of 125 ft. They feed a common hopper which supplies a belt conveyor system used to load the ore onto ships. The Scrapers can be worked from the same pile or shifted to opposite ends of the 100,000-ton storage area by means of two tail towers which travel the perimeter. Both buckets and tail towers are remotely controlled.

Ore from the mine is conveyed to a traveling bridge where a tripper line conveyor places the ore on the stockpiles. Although the ore becomes sunbaked and forms crusts up to five feet thick, the Scraper Buckets operate without difficulty.

DragScraper Machines are economical handlers of bulk material for both indoor and outdoor installations. Sizes from ⅛ to 15 yds. match your requirements. Write or call for our recommendations and further information.

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increased our ore reserves and cheapened our production costs by more efficient and faster operations, and is almost completed. We are at present finalizing our plans to accomplish this by combining corporate funds and OME-Government assistance.

In our Mohawk mine, we recently developed two stope areas in the 500-ft level, averaging in excess of 20 oz silver ore. Both these ore chutes are continuing down dip with very favorable presentation for down development. Our other mines have also developed important tonnages of gold and silver ores.

Obviously, with the imminent price rise of silver, it is good business to complete our development and reap the higher price of silver for greater profits. In addition, the apparent world inflationary spiral points to a price rise or subsidizing of gold mining at some future date.

Our modern mill at Silver Peak, Nevada, operates with only nine men and not twenty-four men as you indicated in your article. This mill is almost completely mechanized, and was completed after 1956. We recently added a sulphur dioxide leaching process for treating manganiferous ores.

Since our company has the only mill for cyanide processing of gold and silver ore within 500 miles, our plans are to be in operations again soon. Our mill is also available for custom milling for other mines in the area.

We have every intention of commencing milling and mining operations after our other work has been completed.

Very truly yours,

R. O. Camozzi,
General Manager
United States Milling & Minerals Corp.

IN CANADA

NEWFOUNDLAND

Iron Ore Co. of Canada is adding a pelletizing plant to its iron ore project at Carol Lake, Labrador. An open pit is being established from which ore will be treated in a concentrator with capacity of 7-million tpy of concentrate, starting next July. The pellet plant, to be built and operated by IOCO, will be owned by Carol Pellet Co., shareholders of which will be a group of U.S. steelmakers which are also shareholders and customers of IOCO. These include National Steel Corp., Bethlehem Steel Corp., Republic Steel Corp., Armco Steel Corp., Wheeling Steel Corp., Youngstown Sheet & Tube Co., and Hanna Mining Co. The plant, with estimated cost of $60-million, will have an initial capacity of 5.5-million tpy of pellets.

Advocate Mines, coming asbestos producer at Baie Verte, is raising its initial production capacity to 5000 tpd from

Typical Combination
Fluidized Bed Dryer & Cooler

YOU'LL FIND NO "HOT SPOTS" IN

LOUISVILLE FLUIDIZED BED EQUIPMENT

Louisville Fluidized Bed units are meeting with unusual success as dryers, coolers and reactors for free-flowing granular materials up to ¼" particle size. Temperatures within the units are remarkably uniform. There are *no* hot spots. The high rate of heat transfer and the constant turbulence inherent in their operation create conditions that for all practical purposes are isothermal.

The operating range of Louisville Fluidized Bed Equipment is from 50° F. in the case of coolers to as high as 1500° F. in calciners and reactors . . . up to 2500° F. in special cases. By measuring and controlling exhaust temperatures, bed temperatures are maintained within narrow limits.

Response to desired changes is practically instantaneous. Because of this sensitivity to change, the critical temperature of the material being treated can be more nearly approached than in any other kind of dryer or reactor . . . as close as 2° F. in many operations.

For more information about Louisville Fluidized Bed Equipment, please write for Bulletin FBD-61

Process Equipment Division—Louisville Dryers

GENERAL AMERICAN TRANSPORTATION CORPORATION

135 South LaSalle Street *Chicago 3, Illinois*

EXIDE POWER PACKAGE— THE BIG, NEW ECONOMIZER

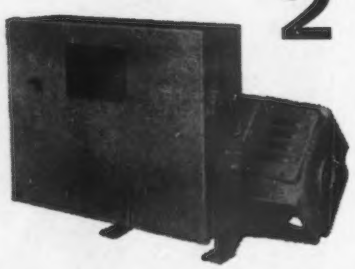
1

Low-cost battery power

For any mine locomotive, there is one particular type and size battery that best meets your requirements. And only Exide offers so broad a range of types and sizes. Let your Exide man recommend the one battery that's best for you. The Exide line includes Exide-Ironclad, with new higher capacity and longer life potential; Exide-Powerclad, premium quality flat plate battery; and Exide nickel-iron-alkaline, invented by Thomas A. Edison.

High-efficiency chargers

2



Install high-efficiency Exide chargers with your batteries and save money on your power. Buy your chargers as part of an Exide power package. Your Exide man will recommend the size and type charger that fits your needs exactly. So you get complete charging and don't pay for unneeded capacity. Correct charging rate helps prolong the life of your batteries. Choice of either rotating or rectifier type chargers.

3

Fast, dependable service

The complete Exide power package is the lowest-cost way of getting the maximum for your battery dollar investment. Exide service men, factory-trained specialists in Exide equipment, will help you attain lowest cost through long service life. Over 200 specialists located from coast to coast available to give you prompt service when you need it.

For complete information on the economies of the Exide power package, write Exide Industrial Marketing Division, The Electric Storage Battery Company, Philadelphia 20, Pa.

Exide® INDUSTRIAL MARKETING DIVISION (ESB) The Electric Storage Battery Company

the previously planned 3000-ton rate. Target for production start is still July 1, 1963. Behind the change is a new ore reserve estimate; now 41-million tons compared with the earlier 35-million tons.

Maritimes Mining Corp. has encountered two new orebodies in flat drilling on the 1000-ft level at its Tilt Cove copper mine. South of the shaft, at a distance of 300 ft, a hole returned 55 ft averaging 2.46% copper. The section is in an area otherwise unexplored below the 650-ft horizon. The second new showing lies some 1500 ft north of the shaft. It has been cut in two holes: one returning 10 ft averaging 1.08% copper; the other, 200 ft along strike, showing 20 ft grading 1.04% copper.

QUEBEC

Vauze Mines has become Quebec's newest copper producer. Its 350-ton mill is already close to capacity, and the first concentrates have been shipped to the Noranda smelter. The mine is operating on proven reserves of 144,000 tons averaging 6% copper, 4.7% zinc and 2.2 oz silver per ton, plus an additional 40,000 tons of lower grade.

Lake Dufault Mines, adjoining Waite Amulet and Vauze Mines in the Noranda area, has found indications of a major orebody. A vertical drill hole from surface, at depth of 1076 ft, cut 153.5 ft averaging 4.0% copper, 12.2% zinc, 3.8 oz of silver and 0.04 oz gold per ton.

A second hole, 100 ft to the west, missed. But the third boring, 100 ft east of the discovery hole, disclosed the orebody's extension.

Dumagami Mines, a new company, has started drilling a promising property in the Mattagami area. Located alongside the new townsite of Mattagami, the ground adjoins the claims on which copper was disclosed in drilling this year by Radiore Uranium Mines. Geophysical work has shown strong anomalies.

Ragalan Nickel Mines, following the close of the 1960 exploration season, estimates that it now has an indicated 3.9-million tons grading 1.66% nickel and 0.78% copper on its ground in the Wakenham Bay sector of northern Ungava. This year's drilling totalled 17,000 ft, and a program of 35,000 ft has been laid out for 1962.

Lyndhurst Mining Co. is carrying out a ground geophysical survey on its property 30 miles north of Noranda. In former operations five levels were opened, and ore was shipped, but the project closed in 1957. The new work is being done in search of zone extensions.

New West Amulet Mines is drilling its base metals prospect adjoining Waite Amulet in the Noranda area. The first holes are designed to reach at least 1000 ft depth.

Opemiska Explorers Ltd. is undertaking geophysical work and diamond drilling

For carloads or small lots

Eighteen convenient smelters and refineries

ASARCO

ASARCO: Buyer, smelter, refiner of gold, silver, lead, copper and zinc ores and blister copper, concentrates, mattes and residues. Fourteen domestic and four Mexican plants located for maximum accessibility as follows:

LEAD SMELTERS
Selby, California
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El Paso, Texas
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Amarillo, Texas
Corpus Christi, Texas
Rosita, Coah., Mexico

COPPER SMELTERS
Hayden, Arizona
El Paso, Texas
Tacoma, Washington
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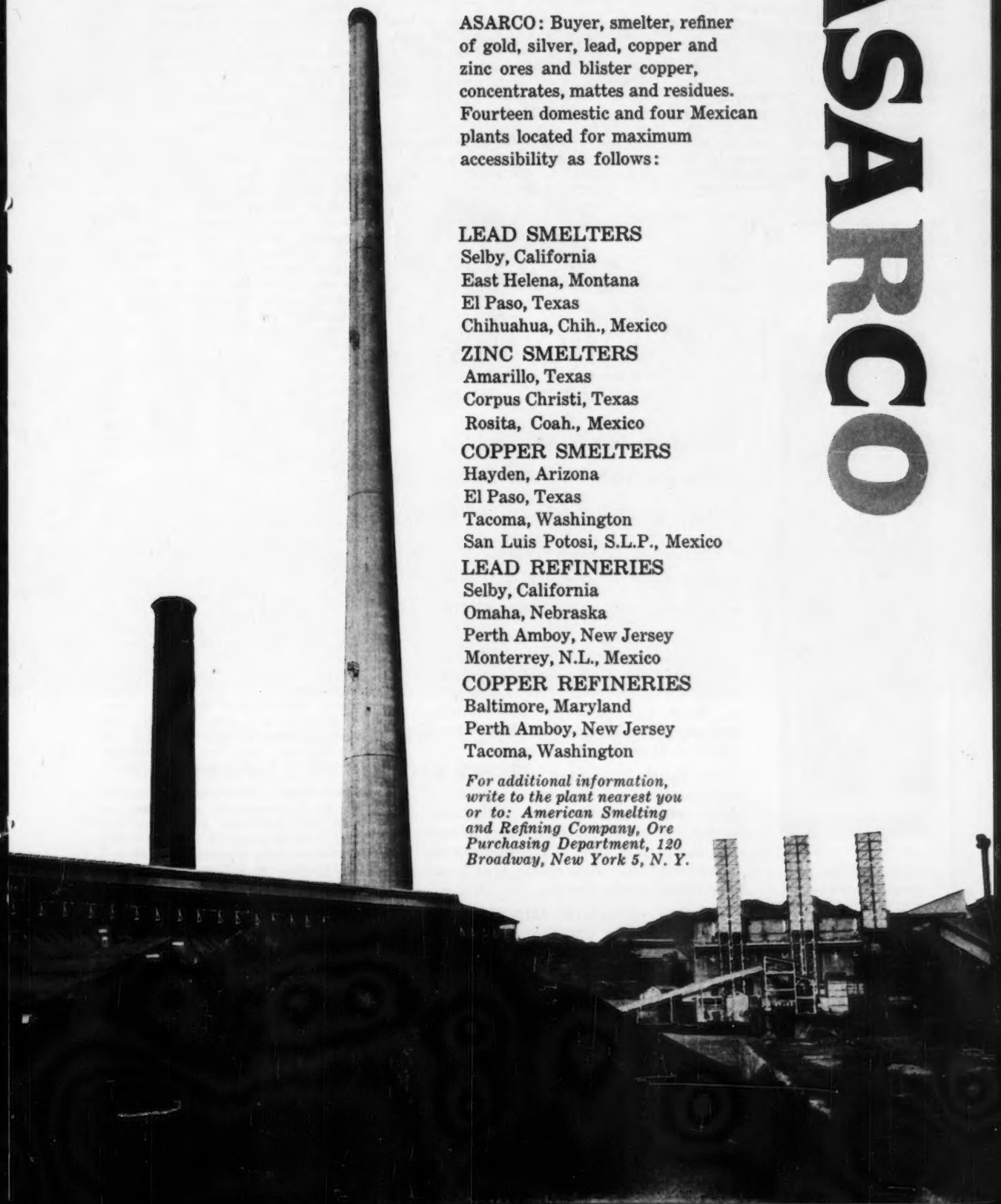
Omaha, Nebraska
Perth Amboy, New Jersey
Monterrey, N.L., Mexico

COPPER REFINERIES
Baltimore, Maryland
Perth Amboy, New Jersey
Tacoma, Washington

For additional information, write to the plant nearest you or to: American Smelting and Refining Company, Ore Purchasing Department, 120 Broadway, New York 5, N. Y.



on a new group acquired in Dufresnoy and Clericy Twps., northeast of Noranda. Previous aerial surveys indicated a magnetic anomaly.

Mentor Exploration & Development Co., along with associates Norgold Mines and Destorbelle Mines, is drilling a base metals prospect in Mattagami's Gallinee Twp. Mentor has a 50% interest, the others 25% each. Geophysical work has indicated five good looking anomalies.

Quebec's long awaited zinc refinery is on its way at least. Controlled by the Noranda organization, it is to be located at Valleyfield. Estimated cost is $20-million. Primarily designed to treat concentrates from the companies owning it, the electrolytic reduction plant will presumably also accept custom business from others. Shareholders are Mattagami Lake Mines (62½% interest), with Orchan Mines, Geco Mines, Quemont Mining Corp., and Normetal Mining Corp. The three latter are already producers, while Mattagami and Orchan are in the mill-building stage.

Tache Lake Mines has made a high grade copper discovery at Lake Romanet, 110 miles northwest of Schefferville and 50 miles southeast of Fort McKenzie, in the Ungava region. One channel sample showed 4.6% copper across width of 23 ft, while character samples from other parts of the showing showed assays of 7-8%. Little is known yet about the find, but the main mineralized structure has been traced for four miles, while the related shear zone has been identified for a considerably greater distance. The area is remote, but a full-blown staking rush has developed. The district is unsettled, and all ground is open.

Canadian Dyno Mines has an intriguing high grade surface copper find at Duncan Lake, some 55 miles east of Fort George, a station on the east shore of James Bay. One trench has been opened across the showing, and channel sampling across 44 ft gave 8.1% copper and 1.13 oz of silver; a richer section in the south part of the trench returned 13.9% copper and 3.08 oz of silver across 22 ft. The mineralization is heavy to massive sulphides, predominantly chalcopyrite, in an east-west shear zone. The find was made by Dyno on ground held by Duncan Range Iron Mines, which Dyno was exploring under an agreement which gives it an option on 75% of Duncan Range's capital. Dyno has subsequently staked 144 claims on its own account, and the find sparked a rush of staking that brought many other companies into the area in search of ground. Claims have been acquired by Satellite Metals, Grandroy Mines, Anacon Lead, Chimo Gold, Augustus Exploration, Consolidated Mogul, New Athona Mines, Radiore Uranium and others. Drilling on the new find will be done this winter. The Duncan Range ground was primarily a low grade iron ore prospect, with 750-million tons grading about 32% iron.

ONTARIO

Geco Mines has encountered remarkable success in opening up its new bottom level at the 2450-ft horizon. Drifting and drilling have disclosed ore for a length of 1825 ft, with average width of 96 ft. Grade is good mine average, 1.81% copper, 4.02% zinc and 1.44 oz of silver. With volume of 17,000 tons per vertical ft, the level is one of record proportions in Canadian base metal mining. Production at the mine is back to normal. The operating difficulties which hampered mining earlier in the year have been overcome. Production for the year will be close to that of 1960.

Nickel Mining & Smelting Corp. is making good progress in establishing its mine for production next year. The shaft is being deepened 600 ft to 1800 ft, to open levels at the 1350, 1500 and 1650-ft horizons. Mill construction will start next spring.

With unwatering complete, Silvermaque Mines is starting an underground drilling program at its property in the Cobalt area. The property is a former silver producer, and work will be concentrated on the three main vein structures which were the chief source of ore in previous work.

North Coldstream Mines has encountered disappointment in opening its bottom level at 1400 ft. Ore in the favorable zone appears to bottom at about the 1250-ft level, no values of conse-

CHECK THE NEW

Connellsville

MINICAGE

(TRADE MARK)

The Service Elevator for Preparation Plants and Underground Installations

- REDUCE DOWN TIME
- ELIMINATE FATIGUE
- SPEED UP MAINTENANCE

This all-steel Connellsville MINICAGE with 1000 lbs. and up capacity travels the outside wall of an existing preparation plant . . . or may be designed for inside a future-planned facility. Operates automatically at speeds of 50 to 75 feet a minute.

The sturdy fabricated steel structure with pantograph-style gate is mounted in place and safely attached to wall. Drive assembly at top of structure is coordinated with the MINICAGE and level doors by a control system. Wall openings at levels have hinged safety doors.

The entire Connellsville MINICAGE installation complies with federal and state mining laws.

For additional information and details on the Connellsville MINICAGE and other elevators, cages, hoists and conversion units, write for Bulletin No. 200.

Connellsville Corporation

Raising Production Since 1901

formerly Connellsville Mfg. & Mine Supply Co.
CONNELLSVILLE, PENNSYLVANIA

Why Yieldable Arches are so effective in control of spalling roofs

Steel *for Strength . . . Economy . . . Versatility*

In a large coal mine in West Virginia, the immediate roof is bone coal, slate, sandstone, sandy shale, and other materials difficult to control. During mining operations these overlying strata often broke off and fell into the workings.

Bethlehem's Yieldable Arch provided the most dependable and economical answer, because it was designed to "give" under extreme pressures and impacts. Lagging and packing around the Arches catch the falls as they occur, and transfer the load to the steel arch sets. The Arches yield a little at a time as pressure builds up, thus allowing the roof to arch over and stabilize itself.

A Yieldable Arch set consists of U-shaped segments which are heavily flanged to resist torsional stresses. The segments lap each other at the ends, where they are secured with pairs of husky U-bolt clamps to provide a friction joint. When loads overcome the friction the Arch yields gradually to relieve the pressure, at the same time giving the overburden a chance to establish equilibrium.

Many mines have discovered that Yieldable Arch installations pay for themselves in a matter of months. A Bethlehem engineer will welcome the chance to discuss with you the advantages of Yieldable Arches in your mine.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA. *Export Sales:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

STEARNS INDOX V Magnetic Separators Make Believers Out of Customers... Competitors, Too

Amazing new permanent magnet material provides important efficiency improvements at lower cost in ore concentration applications.

Before 1958, users of magnetic separation equipment had no choice but to buy electromagnetic units when the job required a deep and powerful field. Then from Stearns came INDOX V—a permanent magnet material which not only provided the field strengths needed but permitted separator designs that were less costly to install, maintain and operate. Further, INDOX V-equipped wet drum separators and permanent magnetic head pulleys are not subject to the costly, time-robbing breakdowns encountered with electros as a result of insulation failure due to moisture.

New INDOX V 36"x 72" wet double-drum separator — equals performance of the best electros while saving money in ore cobbing applications.

INDOX V Opens New Design Era

But what is INDOX V? It is a highly oriented barium ferrite ceramic magnet material developed by Indiana Steel Products, Division of Indiana General. INDOX V possesses unique advantages for separator design—lightweight, high electrical resistivity, great resistance to demagnetization (stable to −40° C), and high magnetomotive force per unit of length. Made of low-cost, non-critical raw materials, INDOX V supplies an energy product, on an equivalent weight basis, equal to ALNICO V and three times greater than that of ordinary un-oriented ceramic magnet material.

Design Experience Pays Off — For You

Because of the increased design flexibility and other advantages offered by INDOX V, Stearns engineers were able to achieve dramatic improvements in separator efficiency with the added bonus of low cost.

For example, with the advent of INDOX V it became both *practical* and *economical* to employ permanent magnet radial pulleys or wet permanent drums in ore cobbing applications. And as you well know, these are the jobs that separate the men from the boys.

Stearns pioneered the use of ceramic magnets in mining separators, and the results of this experience can be seen in the large number of *job-proved* INDOX V separator installations in ore processing plants throughout the world. The recent widespread switch to ceramic permanent magnets in the magnetic separation equipment industry gives further proof of the success of INDOX V in these applications.

Broadest Equipment Line

Stearns offers a complete line of job-proved INDOX V-equipped drums, pulleys and complete pully separator units to handle any ore concentration application—cobbing, roughing or finishing, wet or dry. And, for those jobs that require frequent variation of field strength, we continue to offer electro separators employing the latest in coil design.

To take advantage of this unmatched experience, call in a Stearns engineer today for a *job-studied* recommendation and price quotation. Literature sent on letterhead request.

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quence having been disclosed below that depth.

Ibsen Cobalt Silver Mines has leased 20 claims in the Temagami area to Strathagami Mining Co., subsidiary of Cleveland-Cliffs Iron Co. The lease, a 100-year contract, is on a royalty basis. Ibsen to receive 45¢ per ton for all iron ore concentrates sold, with advance payments of $5000 per year. Strathagami, which holds extensive ground in the district, is considering plans for large scale production. Its drilling has covered a strike length of seven miles along the known range.

McWatters Gold Mines and Quebec Manitou Mines have combined to drill a nickel prospect 25 miles southeast of Timmins. The claims are featured by a peridotite intrusive, and geophysical surveying has indicated several anomalies that warrant testing.

High grade silver ore has been found by Deer Horn Mines at its Cobalt area property. A raise from the 800-ft level found ore from which muck samples ran 40-50 oz per ton, with typical Cobalt patches of leaf silver that produced hand-cobbing ore of 2000-oz grade in some places. Meanwhile the mill continues to run at 85 tpd, with heads running from 15-20 oz per ton.

Big Jackpot Mines is drilling a copper-silver prospect in Tudhope Twp., Elk Lake area.

NOVA SCOTIA

The hunt for base metals in Nova Scotia reached its most intensive level this year. Government officials are optimistic that the large-scale exploration program will lead to important discoveries.

Deputy Mines Minister Dr. J. P. Nowlan said the reason for the increased exploration, the greatest in the province's history, is a belief that ore deposits discovered around the Minas Basin community of Walton are considerably more important than first realized.

Silver concentrate production by Magnet Cove Barium Corp. at Walton recently went on a round-the-clock schedule. It was the first new metal mining operation in Nova Scotia since 1956.

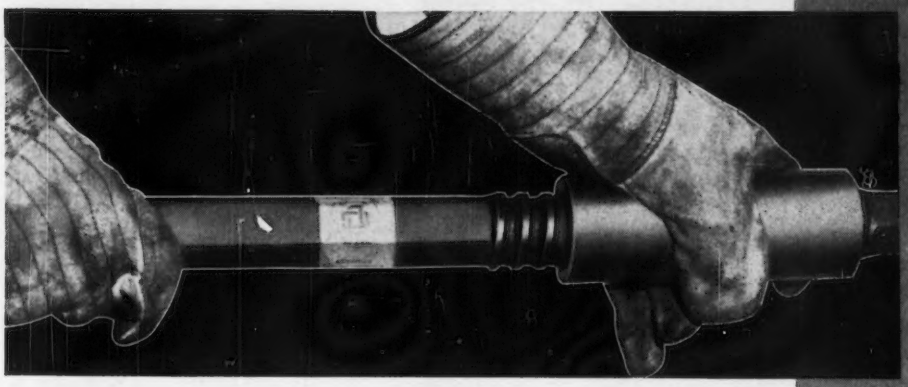
IN LATIN AMERICA

BOLIVIA

The United Nations Special Fund and the Government of Bolivia have agreed to cooperate in a four-year $1.6-million pilot search for new minerals in a selected area of the Cordillera and the Altiplano—the spine and high plateau of the Andes.

Modern prospecting techniques and equipment will be used in an area ranging in elevation from 13,000 to 16,000

GARDNER-DENVER HI-LEED® STEEL



Prove it on your jobs —easiest to uncouple

On job after job, Gardner-Denver's HI-LEED sectional rod proves itself. It always uncouples readily. It saves time coming out of the hole. You can save time adding new steel in drilling hole. You profit by all these HI-LEED advantages:

Reduces steel breakage—less downtime due to losing steel and bit in hole. Fewer lost holes. Lowers cost of steel and bits.

Prevents lost holes—because HI-LEED design keeps mating parts snug; rods won't uncouple in the hole or while pulling out.

Sends more impact to the bit—because rod and coupling threads are in close contact over a large total area; rod ends are held firmly together.

Drills more footage per rod—because steel is carburized and shot-peened; wide-thread peak assures maximum wear.

These outstanding features of HI-LEED steel can help save your profits. Test HI-LEED steel on your drilling jobs. Want more details? Ask your Gardner-Denver Rock Drill Specialist, or send for Bulletin HLDS-1.

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

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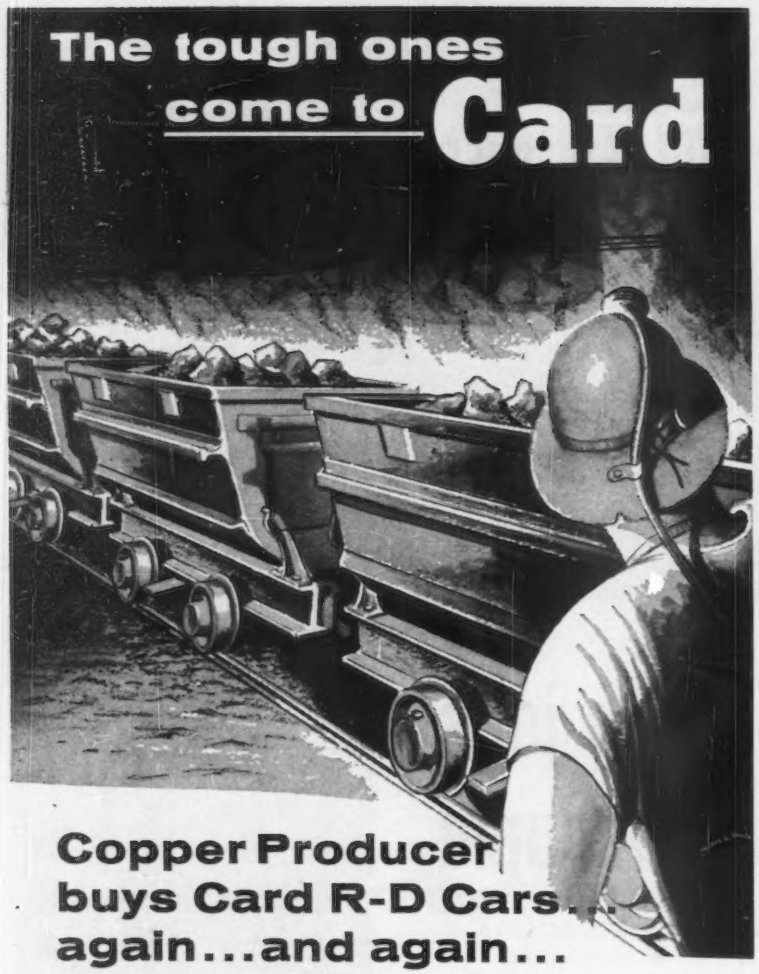

Copper Producer buys Card R-D Cars... again...and again... ...and again!

Four successive orders for these Card Rocker-Dump cars have been filled for an Arizona copper company since 1955. They are a standard Card design fabricated of U S S Cor-Ten steel plate with abrasion resistant steel plate liners. So durable are these 60 cars that even after 60,000 tons of highly abrasive copper ore haulage per car, not so much as a liner plate has required replacement. The only out-of-service time for any of these cars has been for normal wheel servicing.

The same low-cost haulage can be yours with a Card-built train of mine cars. There are many styles and sizes available, both in standard and in special designs. We can build to your specifications. Let our sales engineers help you plan—now.

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ft above sea level, where known resources include lead, tin, bismuth, antimony, tungsten, silver, gold and copper.

The Special Fund will contribute $922,000 for experts, equipment and contractual services for the pilot mineral survey. The government will contribute the equivalent of $685,000 for professional staff, administrative personnel, drilling equipment and crews' labor and all the services and supplies available in the country. The project will be carried out by the United Nations as the executing agency.

The area which is to be surveyed is a rectangle of some 43,000 sq km (or about 17,000 sq miles) south of the town of Cochabamba. It was selected because of the number of working mines there and the known mineral occurrences of considerable quantity and diversity. It is also well served with railroads, including a line connecting the area with the main seaport of Majillones in Chile.

The project is an outcome of the government's decision to conduct fresh explorations on a scientific basis to determine the existence of new mineral deposits that can be profitably worked. Following a decline in the exports of minerals from Bolivia in recent years, mineral development has been given high priority in the government's development program for 1960-1964.

A National Department of Geology has been established to promote exploration and coordinate and disseminate all studies carried out by government agencies and private undertakings. The Department is receiving assistance under a five-year agreement with the Agency for International Development for the training of geologists. Numerous preliminary studies have been made by experts serving under bilateral and multilateral programs, and the project request for the Special Fund survey was prepared with the assistance of a United Nations expert.

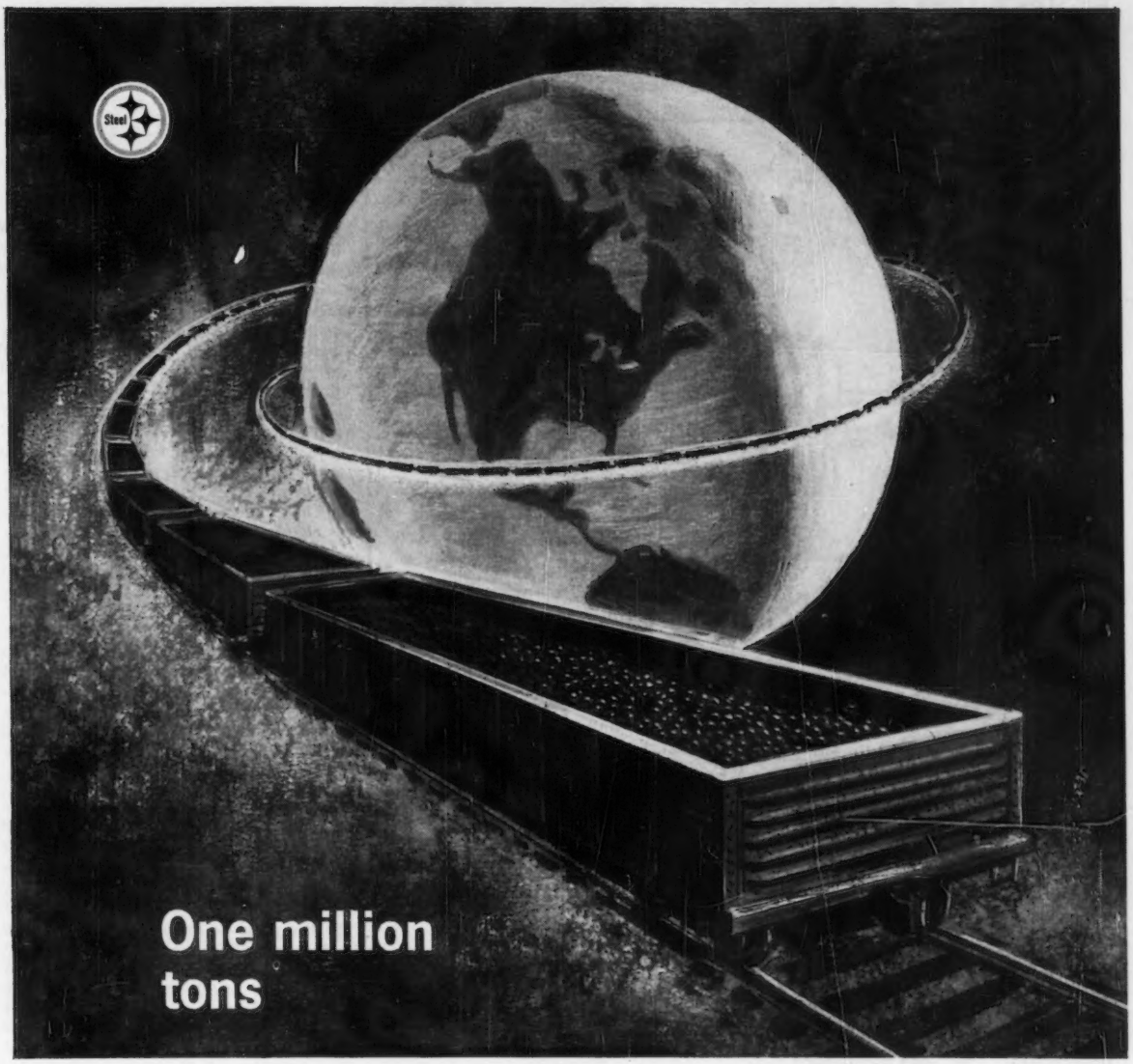
Total Bolivian Mineral Exports For January/August 1961

Bolivian total mineral exports (nationalized and private minings) for January/July and August, 1961 are the following, according to Gvernment official figures:

Mineral	*January/July*	*August*
	— (Kilos) —	
Tin	12,974,832	1,549,451
Silver	81,263	12,202
Lead	13,674,098	2,039,550
Bismuth	96,477	15,721
Copper	1,079,954	149,727
Wolfram	878,200	125,470
Zinc	2,276,362	353,915
Antimony	3,484,546	406,238

BRAZIL

Brazil's major iron ore exporter, Companhia do Vale do Rio Doce, has announced the signing of an agreement with the Japanese Commercial Mission for the supply of 5-million tons of hematite per year for Japanese steel mills at prevailing world prices for ten to fifteen



have earned customer acceptance

More than a million tons of Sheffield Grinding Balls of all kinds have proved their worth, throughout the world. This record of performance is no accident. It's the result of tight, quality control of alloying, heat-treating and forging — every step of the way. Sheffield Moly-Cop Balls keep their sphericity longer, give a better, more uniform grind, at the lowest possible cost per ton. No wonder Sheffield Grinding Balls are the standard of comparison, around the world. **Sheffield Division, Armco Steel Corporation, Sheffield Station, Kansas City 25, Mo.**

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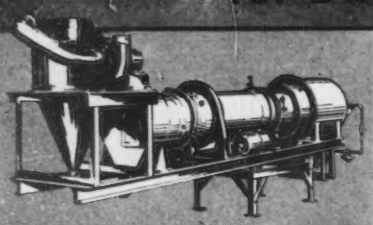
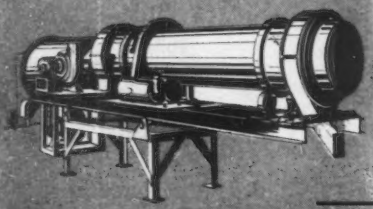
Pilot Plant or Laboratory Equipment . . .

for DRYING



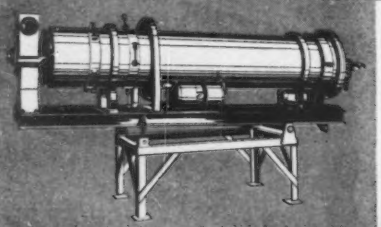
SINGLE-SHELL DRYER

Single-shell, direct gas fired rotary dryer. Arranged for either parallel or counter-flow operation. Mounted on structural steel base. Has removable "knockers." Bulletin AH-471.



DOUBLE-SHELL DRYER

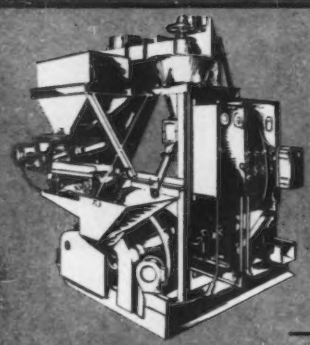
Double-shell, indirect-heat, gas-fired dryer for drying without contamination. Volatiles removed with only limited dilution. Shell rotation speed and shell slope easily changed. Bulletin AH-472.



STEAM TUBE DRYER

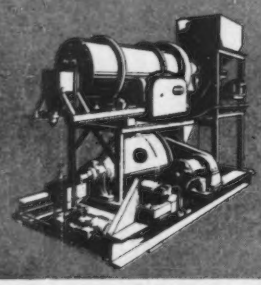
Steam-tube indirect heat dryer. Can be connected to any available steam supply or furnished with a 3-HP steam generator. Available in stainless steel or other corrosion-resistant materials. Easily moved from place to place. Bulletin AH-473.

for GRINDING AND CLASSIFYING



DRY GRINDING UNIT

Make power connections only and the Hardinge Dry Grinding Unit is ready to perform. Self-contained and portable, 7' 8" high. Complete with Constant-Weight Feeder, Conical Mill, "Gyrotor" Classifier, dust collector, product collector and "Electric Ear" grinding control. Bulletin AH-448.



WET GRINDING UNIT

Power and water connections only are needed to put the Hardinge wet grinding unit into operation. Self-contained and portable, 6½' high. Includes Conical Mill, Counter-Current Classifier, launders, feeder, pump and "Electric Ear" grinding control. Bulletin AH-448.

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years. This will mean $40- to $50-million annually for Brazil's foreign exchange coffers. Brazil has agreed to enlarge port facilities for ships up to 60,000 tons.

CHILE

ENAMI, formerly the Mining Credit Bank, will soon start building a 100-tpd leaching plant by the agitation method at the old nitrate port of Taltal, Antofagasta province. The same government Agency will also build a leaching section at the El Salado mill located 19 miles east of the port of Chañaral where it also plans to build a sulphuric acid plant by the contact process. Low grade oxide copper ores are plentiful both at Chañaral and Taltal where until now the small miner could not dispose of them as their grade is too low to be smelted direct at the Paipote copper smelter much further to the south.

Through these two new plants 3% oxide copper ores can be transformed into 75% copper cement, made into briquettes and smelted in converters at Paipote.

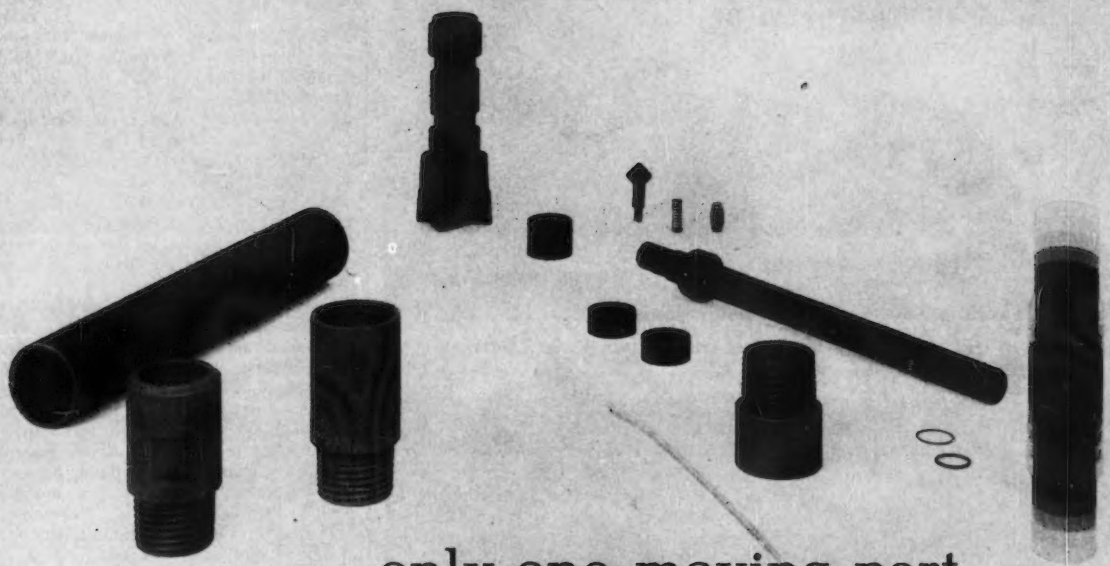
ENAMI is also leaching, by percolation, oxide copper ores at the Domeyko mill originally built to treat gold ores by flotation and cyanidation. The copper ores are sold by the small miners around the Domeyko mill and the sulphuric acid is trucked from the Ojancò's plant at Copiapo.

Armco International Corp. together with Compañía Electro Metalúrgica of Chile have built at Huachipato, site of the country's new steel mill at Concepción province, a modern plant to supply the whole of the country's mills with all the grinding balls they require. The new company will be known as Armco Chile, S.A.I., and will have an initial capacity of 18,000 metric tons of steel balls a year to be increased as needed to 26,000 metric tons of steel balls a year. The high carbon steel required for making the balls will be supplied by Compañia de Acero del Pacífico—Huachipato Steel mill.

The balls made at the new plant will be exactly similar to those made by Armco in the United States, that is, hot forged and heat treated to give them the required hardness.

Unil the construction of the present Armco plant which cost $2.4-million, 70% of which was supplied by Armco and 30% by the Chilean company, imported balls cost the country almost $5-million per year. Electro Metalúrgica of Santiago has been supplying balls and liners for many of the mills in the country for many years past.

For the official inauguration of the plant which took place recently, Messrs. A. R. Edwards and M. L. Johnston, president and executive vice president of Armco International, made a special trip to Chile. Armco balls are already being used at the Chuquicamata, El Salvador and La Africana mills of Anaconda Mining Co. and are at the present time being tried at El Teniente mill of Braden Copper Co.



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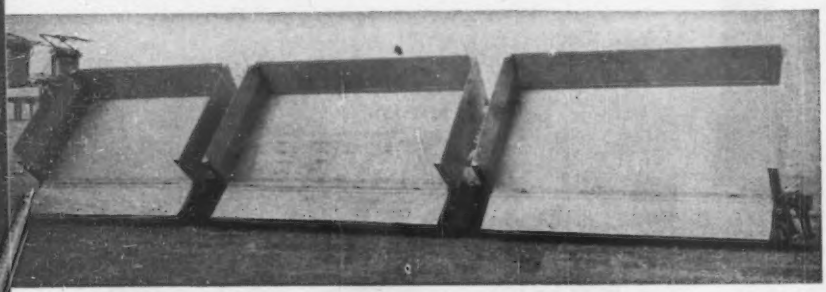

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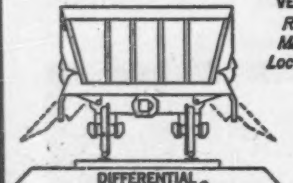

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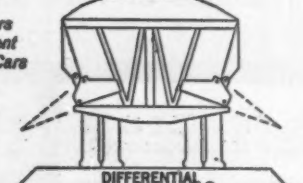


Rent Differential WAGON TRAINS from DIFCO, Findlay, Ohio

Señor Enrique Serrano, the Secretary for Mines has resigned and has been replaced by Señor Chaná who, until raised to Cabinet rank, was Superintendent of Chilean Limited Liabilities Companies, a government agency whose function is to supervise Chilean corporations.

Japan Steel and Tube Corp. will build for San Juan Carriers of Chile a 67,500 ton iron ore carrier. Construction of the ship will start next February and according to the builders can be delivered to the owners by the end of September 1962. This will be the largest ore carrier to ship iron ore from Chilean ports. Because high tension steel plate will be used in its construction, 35 mm steel plate will be used instead of the usual 50 mm (2 in.) plate.

PERU

The first shipment of dredge components scheduled for Natomas Co.'s gold dredging venture in Peru left Encinal Terminal Friday, Oct. 20. The shipment, consisting of 250 tons of disassembled dredge parts, represented the first of five 200-300 ton shipments scheduled to depart Encinal during October. Representatives of Natomas Co., Arthur J. Fritz & Co., the Pacific/West Coast Conference, and Encinal Terminal were on hand to witness the loading of some of the large pieces.

Upon arrival at the port of Matarani in Peru, the dredge components will be loaded aboard railroad flatcars for the 250-mile journey to Juliaca, and from there will be transported another 100 miles by truck to the dredge site at Poto—16,000 ft above sea level on a high plateau region in the Andes. Except for heavy rains which might hamper trucking operations for a few months during the rainy season (November-March), the climate at the dredge site is not severe and will not impede a year-round dredging operation.

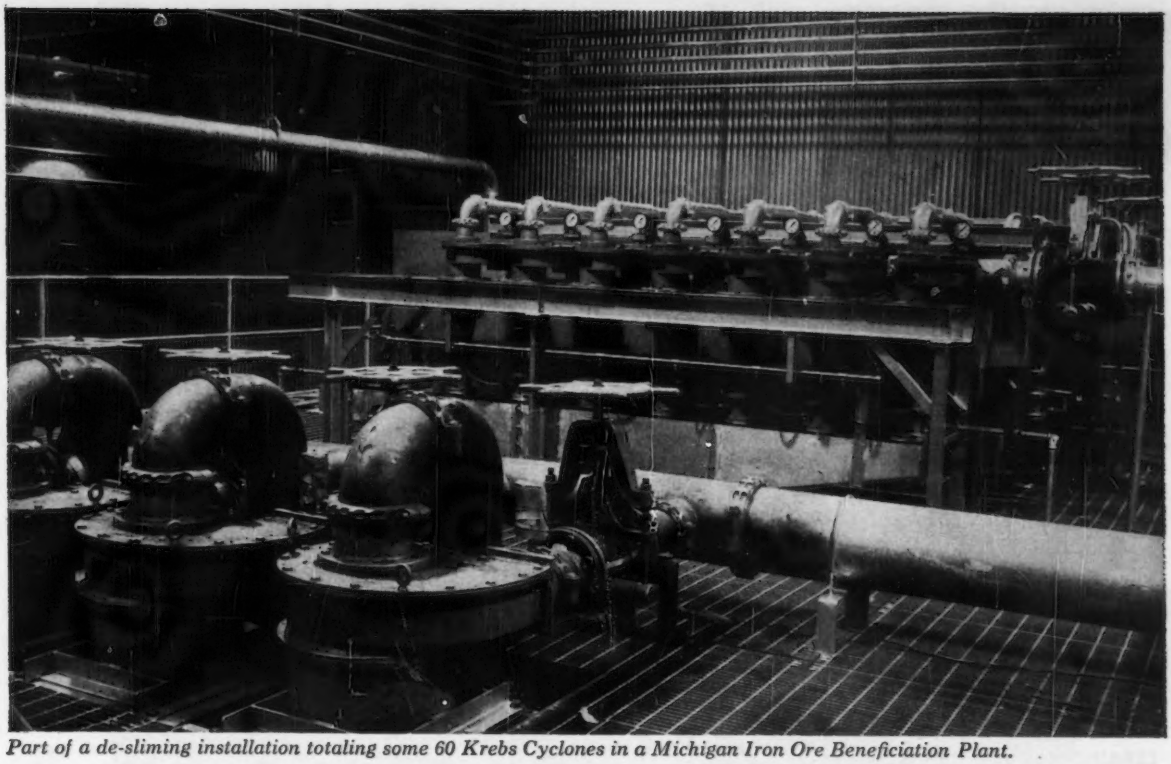
The Company's wholly-owned subsidiary, Natomas Co. of Peru, has already started excavation of a deep pit at Poto in which the dredge will be reassembled. Mr. A. R. Peterson, vice president of Natomas Co. of Peru, will be in charge of all phases of the Peruvian operation.

The shipment climaxes two years' effort on the part of the company and interested parties in Peru involving extensive exploration of the concession area at Poto, and passage of legislation by the Peruvian Congress permitting Natomas to conduct gold dredging operations there.

IN EUROPE

FINLAND

After the Russians annexed the Petsamo nickel deposits in 1944, Finnish geologists scoured the country for new deposits. In 1959, mining operations were begun at Kotilahti, Central Finland, and by late



Part of a de-sliming installation totaling some 60 Krebs Cyclones in a Michigan Iron Ore Beneficiation Plant.

Why Krebs Cyclones give you Better Classification, yet cost less

Greater capacity per unit size Because the involuted feed entry on a Krebs Cyclone minimizes turbulence and pre-orients particles for efficient classification, a larger vortex finder can be used for a given size cyclone, providing higher capacity and equivalent separation for a given pressure drop. This same design feature can be used advantageously to obtain a finer separation for any equivalent cyclone, orifice combination and pressure drop.

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Because Equipment Engineers Inc. is devoted exclusively to cyclone technology, you get all the advantages of dealing with a specialist when you specify Krebs Cyclones. Your classification problems are studied by a staff of skilled engineers representing an unmatched accumulation of experience in the design and practical application of cyclones in the metallurgical field.

A significant factor in the success of every Krebs Cyclone installation is the careful engineering analysis which precedes it. To evaluate your classification needs, we maintain a pilot plant equipped for full-scale testing. From analysis of test results, Equipment Engineers metallurgists are able to predict over-all plant performance with a high degree of accuracy. Your inquiries are invited.

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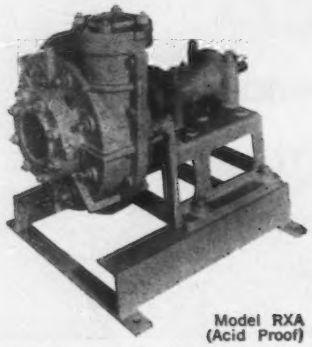
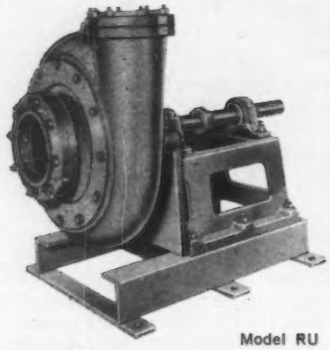


Model RXA (Acid Proof)

CERAMIC lined, at cost comparable to alloyed iron or rubber lined. Range 110′ head/150 GPM to 70′ head/600 GPM. Impellers, liners, shells, **hold up as much as 18 months longer** because of silicon nitride bonded silicon carbide wear parts.



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RUBBER lined. Outlasts metal 5 to 10 times on slurries of 100% minus ¼." No adjustment necessary. Only 3 wearing parts. Semi-open, non-clog impeller. Stainless steel shaft. Available in sizes from 8 x 10" to 3 x 4." Write for complete information

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1960, the state-owned Copper Smelters Ltd. had mined a total of 300,000 tons of nickel ore—from which they obtained 50,000 tons of concentrate and 2,500 tons of metal. By the end of this year, the company hopes to have increased the ore yield to 350,000 tpy.

Kotilahti ore is shipped to the Outokumpu smelter where it is refined by the Finnish-developed process of flash-flame smelting. Engineers at Outokumpu developed the fuel-saving smelting process in which the actual refining is carried out at only 2400°F.

SPAIN

Spain's "Junta de Energia Nuclear" filed with the International Atomic Agency in Vienna a scaled-down price offer to replace previous bid to sell 140 tons of uranium concentrate or the same amount of anhydrous uranium trioxide.

The recent Spanish bid remains open until 1962 and it replaces the first bid it logged at the atomic agency in March 1960.

The new bid filed by the junta offers to sell 140 tons of U_3O_8 at $15.55 per kilo, the price quoted previously was $19.80 per kilo. The price of the anhydrous uranium trioxide is said to be about $18.60, 25% less than the original price marked at $24.80 per kilo.

The uranium fuel offered by the junta comes from its plant at Andujar, south Spain, processing mineral ores from Cordoba and Jaen acreage.

YUGOSLAVIA

Next year, more than $65-million will be invested in Yugoslavia for research, capital investment, and production of rare metals and their alloys. By 1970, the total investment should reach $400-million. Estimated production increases for 1965 over 1960 are as follows: manganese alloys should be increased by 40%; chrome concentrate by 20%; wolfram alloys, 500%; antimony, 30%; mercury, 11.4%; bismuth, 70%; gold, 50%; and silver, 100%.

By 1963, when a plant at Kraljevo, now under construction, will be ready, Yugoslavia expects to produce 600 tpy of magnesium—enough to cover her estimated domestic needs as well as some export.

IN THE FAR EAST

JAPAN

A $6.5-million Export-Import Bank loan for purchase of U.S. equipment to expand

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Its new Butyl *jacket* is the reason for this extra durability in the face of the effects of ozone and moisture and extreme physical punishment.

It is especially compounded to combine flexibility at low temperatures with thermal stability at high temperatures.

Here are other construction features which contribute to this cable's unequalled service record:

1. Anaconda's rubber-core grounding conductors offer a cushioning effect which minimizes pinching and wire breaking and offers greater ground contact protection.
2. Special shielding—a combination of copper cross-braided with cotton—eliminates chafing (and makes splicing faster and easier too).
3. Insulation is a special high-grade Butyl that withstands ozone, heat, and moisture.

Check all the features of this job-proved new shovel cable—they add up to extra cable life, less downtime, and dollar savings. Contact Department EFL-1-PQ, Anaconda Wire and Cable Company, 25 Broadway, New York 4, N. Y.

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ASK THE MAN FROM

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ABOUT ALL-BUTYL SHOVEL CABLE

a Japanese steel plant has been approved.

Loan documents were signed in Washington Nov. 3 by Harold F. Linder, Bank president, and S. Kawata, president of the Japan Steel and Tube Corp. of Tokyo. The plant to be expanded is in the Tokyo-Yokohama area.

The loan will be used for improvements which will give the Tokyo plant a tin plate producing capacity. The firm, the third largest steel producer in Japan also manufactures ships, marine engines and structural steel.

The U.S. is now giving full consideration to the proposed resumption of U.S. purchase of ferroalloy, zirconium and titanium from Japan, according to Government sources.

The Ministry of International Trade and Industry (MITI) reportedly found new hope in the recent Japan-U.S. joint trade and economic committee conference at Hakone, where MITI Minister Eisaku Sato talked with Secretary Luther Hodges about resuming export of these nonferrous metals to the U.S.

Japan exported these metals to the U.S. between 1954 and 1958, but since November 1958, U.S. purchase of the Japanese goods has been suspended because revision of the U.S. act placed them on the embargo list.

The sources said Japan would benefit by the resumption of the U.S. purchase which will save Japan a huge amount of foreign exchange required for the import of agricultural products, and help develop the nation's strategic goods industry.

Japan at present is in the position to export annually 40,000 tons of ferroalloy (worth $15-million), 360 tons of zirconium ($4.5-million), and 4,800 tons of titanium ($12.5-million).

Japan has mined 7-million tons of iron ore from the ocean floor off Tokyo during the past four years, according to Dr. Hiroshi Niino, marine geologist, speaking before the recent National Coastal and Shallow Water Research Conference at the University of Southern California.

Dr. Niino explained that the mining has been done in waters 90 ft deep; that the ore is of excellent quality; and that this new source of iron represents one of the major deposits anywhere in Japan.

"We are the only nation with a substantial marine iron mining operation," Dr. Niino said, "but Japan will not be alone for long. Mining in the sea is one of the new industries of tomorrow. There are rich deposits of various minerals scattered along the continental shelves throughout the world, including the shallow waters of Southern California."

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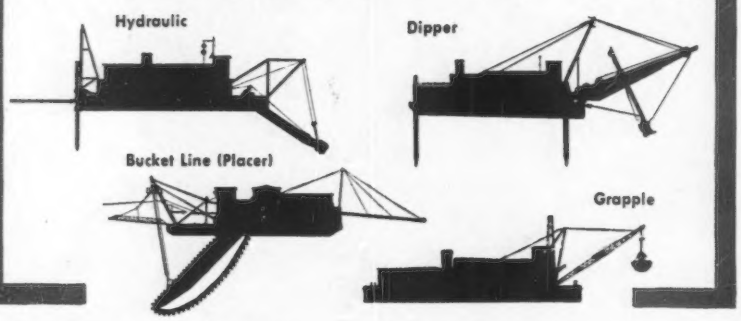
4 basic types, readily adapted for mineral recovery



Ellicott offers a complete range of dredges and dredging equipment, backed by 75 years of experience as designers, builders and service specialists.

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Successors to the floating dredge business of the Bucyrus-Erie Company and the American Steel Dredge Co. Complete engineering, design and construction service.

3021

INDIA

Bharat Reynolds Aluminium Corp. Ltd., the new aluminium company with financial and technical agreement with Reynolds International Inc., of America, has had the terms of the agreement approved by the government.

The authorized and issued capital of the Company will be $21-million and the U.S. collaborators will contribute $8.4-million; the Mysore Government will subscribe $2.1-million; and the promoters $2.1-million; the public will be offered around $8.4-million worth of shares.

The total capital outlay will be around $63-million, including a foreign exchange component of $42-million which the foreign collaborators will take steps to raise from international financing institutions. The chief Indian promoter is the Bombay industrialist, Murarji J. Vaidya.

The present plan is to enter the capital Market before May 1962 and to commence production in 1964. Application for import license for plant and machinery is expected shortly.

NEAR EAST

Sir Ben Lockspeiser, (British) Chairman of Israel's Technological Advisory Board has recommended to authorities to allocate 721,000 IL (roughly $350,000) for the purchase of equipment needed by Negev Ceramics Materials Ltd. for underground and open-cast mining of Flint Clay.

The company has secured the co-operation of an expert associated with "Powell Duffryn" Technical Services Ltd. of London to organize the exploitation of

4 NEW MARION 11-YARD SHOVELS to attack TACONITE

Two major mining companies have each ordered two type 191-M shovels for their taconite operations in the toughest digging in North America. These machines weren't bought on price cuts or out-of-the-yard deliveries. They were bought because the type 191-M has proved, in actual competitive performance, what it can do in taconite, material so tough it will scratch diamonds.

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SUCTION TUBING Two types—MineDuct with enclosed wire reinforcing spiral and ABC Wire Reinforced with exposed spiral wire insert—both the finest quality suction tubing in their range. Same suspension and coupling arrangements as our blower tubing.

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flint clay deposits in the Makhtesh Ramon area (Negev desert).

Besides, 360,000 IL ($180,000) has already been allocated for the building of a pilot plant for the treatment of types 2 and 3 clay by magnetic separation. The company is now in a position to order this plant in a near future. The unit will be capable of treating 12,500 tons of clay, producing 5,000 tpy of upgraded clays (on a one shift basis).

During 1960-61, the Timna (southern Israel) Mining Industries Ltd. has reached a copper cement output of about 5800 tons of 100% copper (as against 5300 tons during the preceding 12-month period). Of the quantity produced, 5200 tons were exported to various markets, mainly Japan, Brazil, France, Portugal.

Output from April 1 to Aug. 1, 1961, in terms of 100% copper, was 2262 tons. At this rate, annual production should reach a total of over 6700 tons.

Since ore reserves at the Timna mine's open pit are dwindling, underground mining will be undertaken within a year or so. Steps are being prepared to this effect, under a five-year plan which also calls for production of 12,000 tons of electrolytic copper, 500 tons of blister copper and 6,000 tons of copper sulphate. (At present, the company is making cement copper only.)

The design of the smelting and fire refining facilities has been completed by unspecified foreign consultants. Specifications of the necessary plant and equipment have been submitted for bids. It is anticipated that proposals will be received before the end of this year when it should be possible to complete the design.

PHILIPPINES

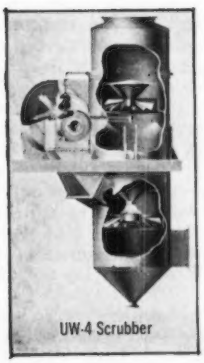
Atlas Consolidated again raised its output in September, milling 372,877 tons at its Toledo mill, and producing 4,215,600 lb of copper. The copper content of the ore, 0.63%, was unchanged from August.

Several asbestos deposits in Zambales province on the west coast of Luzon have excited interest in local mining circles. Other deposits have been found in Ilocos, Pangasinan, and parts of Mindanao, but no development has been done. The Philippine Bureau of Mines is investigating the deposits and will make a detailed report.

Benguet Consolidated, the Philippines largest gold mining company, produced 20,693 oz of gold in September and realized 3,517,000 pesos, equivalent to $724,250. The peso value was based on the Central Bank's buying rate for gold, now 170 pesos per oz. It was formerly 70 pesos per oz before the war, and the higher price represents a subsidy to the Philippine gold mines.

Surigao Consolidated made its first shipment of raw copper ore to Japan in October from its new mine in Mindanao, grading about 9% copper. The company expects to continue shipments at the rate of 1000 tpm.

dustophobia...



ITS CAUSE AND CURE—There are three schools of thought on the cause of Dustophobia. Psychologists say it's psychological, physicians claim it's physiological. We side with the third viewpoint which holds that people hate dust because it's just plain dirty! ■ The cure? Again a divergence of opinion. Hypnosis has been suggested by the psychologists; antihistamines proposed by the physicians. ■ Our solution? Get rid of the cause... with Ducon Dust Collectors, naturally! There's a Ducon cyclone, scrubber or filter for almost every dust control application. They are efficient... economical... and a sure cure for Dustophobia. Particularly in the vicinity of your plant. Send for Bulletin A-9159 describing Ducon's Line of Dust Recovery equipment.

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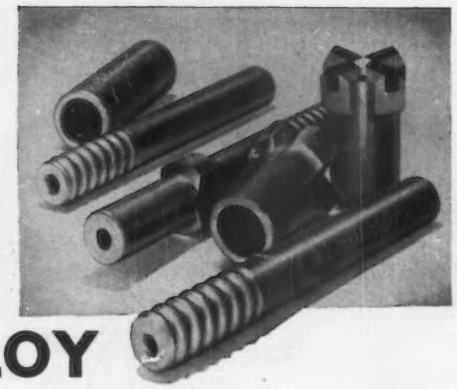

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Consolidated Mines shipped 40,155 tons of refractory grade chromite ore to the U.S. in September, valued at 2,300,000 pesos. Lepanto Consolidated milled 38,000 tons of copper-gold ore in September, producing 2,342,000 pounds of copper and 3183 ounces of gold from ore averaging 3.2% copper and 0.115oz gold per ton.

Good gold ore continues in the Suyoc mine in Baguio down to the 2300 level. Mill heads averaged 0.35 oz per ton in September. The 400-ton mill is operating somewhat below capacity. Ore must be hauled by locomotive about 9000 ft from the mine portal to the mill. The ore is free milling, but needs fine grinding, and amalgamation, blankets, and tables are required for recovering the fines.

The main Suyoc vein exhibits a strong structure and has been developed for 3000 ft from the shaft. Some stopes are 20 ft wide. The ground is heavy and timber consumption is high. It now appears that copper ore may be encountered at depth. Claude Fertig is superintendent.

IN AFRICA

NORTHERN RHODESIA

Mineral production in Northern Rhodesia during August this year was worth an estimated $26,330,614—$2,329,787 less than the value of minerals produced in the previous month.

The value of production in August was also $3,449,690 less than the value produced during the same month last year.

During the first eight months of this year the approximate value of the territory's mineral production was $219,664,542, compared with $252,422,195 during the first eight months of 1960.

The weights and estimated value of the principal minerals produced during August, according to the Northern Rhodesia Government Mines Department's monthly summary, included:

Electrolytic copper, 34,052 tons—$20,159,862; blister copper, 8,472 tons—$4,678,545; zinc 2,525 tons—$496,218; cobalt 7.72%, 31,454 cwt.—$380,847.

Aluminium Ltd. is closing all its bauxite operations in the republic of Guinea at the request of that country's government. The Guinean government asked the company to stop mining bauxite "within the next few weeks" after the company was unable to arrange financing for a proposed aluminum complex at Boke.

Aluminium announced several months ago that its subsidiary, Bauxite du Midi was suspending development of the project until financial difficulties could be worked out.

Aluminium representatives met with Guinean government officials to explain the problem and "at the same time they submitted for consideration proposals for a new approach to the carrying out of the project."

The Guinean government was not willing to consider the proposals, the

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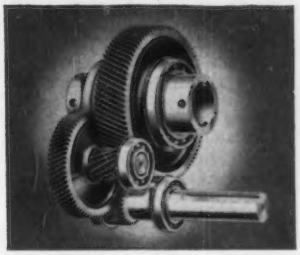

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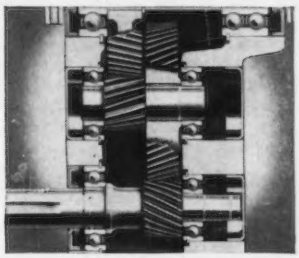

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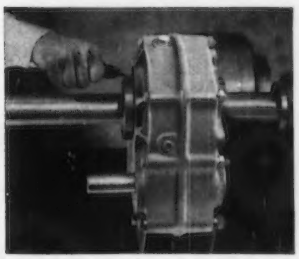

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company said, "and insisted that the long-term convention under which Bauxites du Midi undertook the Boke project be adhered to."

When Aluminium said this was impossible, it was asked to close down all its operations in Guinea.

SOUTH AFRICA

The Atlantic Diamond Corp. is the second company to explore the seabed off South West Africa for diamonds. The company which has a registered capital of $1/4-million has its head offices in Keetmanshoop in S.W.A. and has taken over concession from four other companies covering an eight-mile stretch of coastline north of the Orange River.

The Marine Diamond Corp., the first company to take up scouring of the seabed for diamonds has a 117 mile concession and is already carrying out exploration between the mouth of the Orange River and Luderitz.

Atlantic Diamond Corp. has bought two vessels to operate off Chamais Bay. Larger diameter pipes will be lowered to the seabed and powerful air jets will be pumped in to force the topsoil of the ocean bed up the pipes to the ships. The pipes can penetrate to a depth of 100 ft.

SIERRA LEONE

The Government of Sierra Leone has conceded to the Schweizer Auminium Industrie A.G., in Zurich, Switzerland, the rights to exploit and mine the extensive bauxite deposits discovered last year in the south-western Province of the country. Initially, the concession will run for 15 years but the Swiss company has an option on its renewal.

Exploration already carried out by the Swiss firm indicates that the ore deposits amount to several million tons of relatively rich ore containing from 50 to 60% bauxite. Initial daily production is expected to run at about 400 tons.

The Swiss firm considers that it will require at least 18 months to construct roads and living accomodations, an extensive ore-washing plant, and an ore-loading facility located on a tributary of the River Sherbro. Mid-1963 the first bauxite should be shipped for processing in Italy. The bauxite ore will be mined by the Sierra Leone Ore and Metal Co. Ltd., of Freetown, a wholly-owned subsidiary founded by the Swiss company. The mined ore will be transported to the washing plant and from here to the riverside loading plant by a fleet of specially constructed French trucks.

The tributary of the Sherbro River is only navigable by 6000 BRT freighters, a ship's size not particularly suit-

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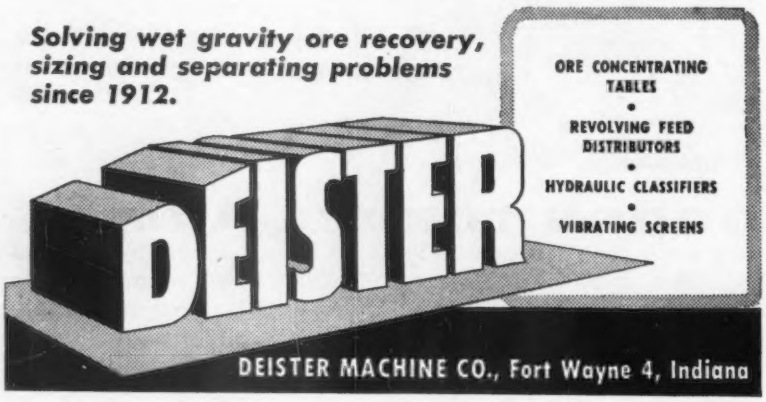

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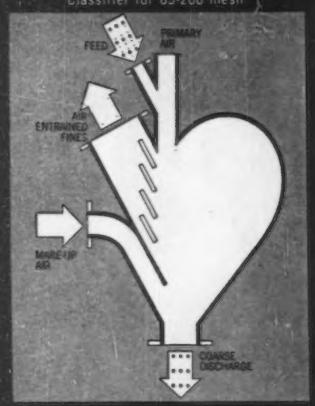

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able for the economic conveyance of bulk ores. But, as the off-loading point at Venice, in Italy, can also only handle freighters up to about 7000 BRT, the Swiss firm has decided that it would be unprofitable to use larger ocean-going ships loaded and unloaded offshore by a fleet of smaller lighters.

IN EUROPE

AUSTRIA

Austria boosted export of raw aluminum during the first half of 1961 to 12,021.9 metric tons worth 154,017,000 Austrian schillings, or $5,923,700. Statistics, just released in Vienna indicate that West Germany was primary customer (5,712 metric tons), followed by Czechoslovakia (1,552 metric tons) and Italy (1,333 metric tons).

On the import side, Austria purchased 64.2 metric tons valued at 1,278,000 AS ($491,500). Main supplier was West Germany (42.1 metric tons) and Hungary (20.0 metric tons).

U.S. customers bought 431.2 metric tons of crude aluminum from Austria during the first six months of 1961, valued at 5,144,000 AS ($197,800); in return, Austria purchased 1.1 metric ton valued at 203,000 AS ($7,807).

Slight increases were noted in Austrian imports of nonferrous metals during the first half of this year; official statistics, just released in Vienna put forth the following figures:

Tungsten: Raw material import of 22.6 metric tons valued at 3,625,000 Austrian schillings ($139,400). West Germany remains primary supplier with 18.6 metric tons, valued at 3,031,000 AS ($116,500).

Molybdenum: Raw material import of 5.1 metric tons, valued at 1,916,000 AS ($73,690). East Germany is main supplier, with 4.0 metric tons, valued at 406,000 AS ($15,610), and Hungary 0.9 metric tons, valued at 1,479,000 AS ($56,800).

Tantalum: Raw materials imports of 2.6 metric tons valued at 4,451,000 AS ($171,100) nearly the whole amount coming from West Germany.

BULGARIA

Bulgaria has put into operation another copper processing plant at Pridop, near Sofia, in response to heavy demand for copper by the East European countries, especially those economically allied in COMECON.

Smelter will go onstream this year with output capacity of 15,000 metric tpy, but existing plans foresee tripling this output to 45,000 metric tpy by 1964.

Copper ore finds estimated at 250-million metric tons-plus in that area prompted plans for scheduling more smelting stations in that district. But no long-range processing capacities are given at this time.

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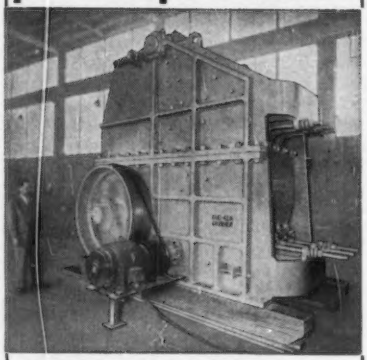

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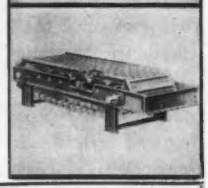

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6—Dunham "Economy" Type 7.
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1—24"x340' Robins Steel Sectional, Less Belt
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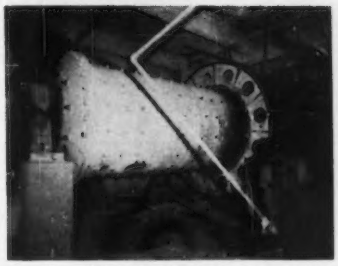

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2—6 ton General Electric, Trolley 250V
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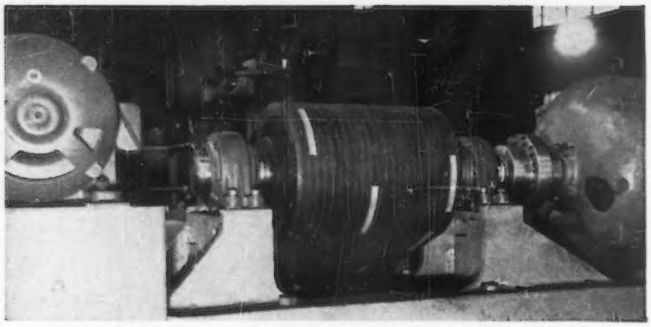
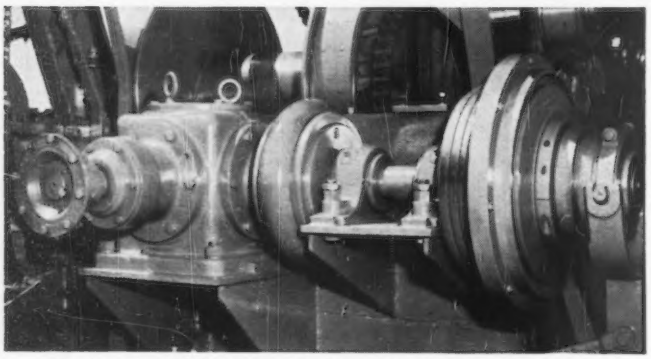
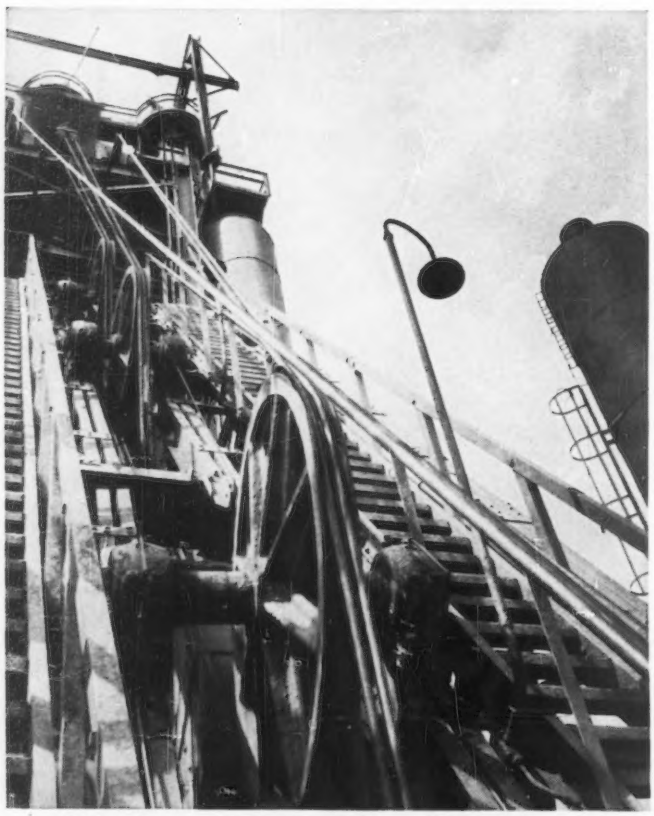


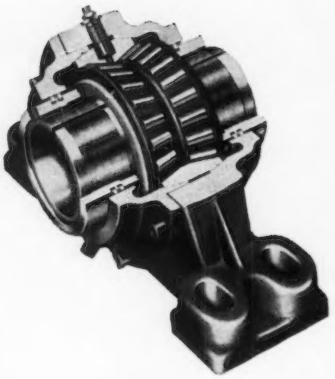
Timken bearing equipped Dodge All-Steel Pillow Blocks used on steel mill hot saw.



Dodge Type "E" Pillow Block with Timken bearings used on drive hookup of a rotary table.



Dodge 7" Special Duty Pillow Blocks with Timken bearings used on skip hoist bull wheel at a steel mill.



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